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COMMERCIAL DEMONSTRATION OF THE NOXSO SO₂/NO_x REMOVAL FLUE GAS CLEANUP SYSTEM

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ENVIRONMENTAL INFORMATION VOLUME

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1 INTRODUCTION

1.1 Purpose and Need for the Proposed Federal Action

The Clean Coal Technology (CCT) Demonstration Program is a \$5 billion technology demonstration program that was legislated by Congress to be funded jointly by the federal government and industrial or other sector participants. The goal of the Program is to make available to the U.S. energy marketplace a number of advanced, more efficient, reliable, and environmentally responsive coal utilization and environmental control technologies. These technologies are intended to reduce or eliminate the economic and environmental impediments that limit the full consideration of coal as a future energy resource. Over the next decade, the Program will advance the technical, environmental and economic performance of these advanced technologies to the point where the private sector will be able to introduce them into the commercial marketplace. Each of these demonstrations is in a scale large enough to generate sufficient design, construction and operation data for the private sector to judge the technology's commercial potential and to make informed confident decisions on its commercial readiness.

The strategy being implemented to achieve the goal of the CCT Demonstration Program is to conduct a multi-phase effort consisting of at least five separate solicitations for projects, each with individual objectives that, when integrated, will make technology options available on a schedule consistent with the demands of the energy market and responsive to the relevant environmental considerations.

On September 27, 1988, Public Law No. 100-446, "An Act Making Appropriations for the U.S. Department of Interior (DOI) and Related Agencies for the Fiscal Year Ending September 30, 1989, and for Other Purposes" ("the Act"), was signed into law. Among other things, this Act appropriates funds to the U.S. Department of Energy (DOE) to cost share the design, construction, and operation of CCT projects that demonstrate the feasibility of technologies capable of retrofitting or repowering existing coal-burning power plants to obtain reduced emissions of sulfur dioxide and oxides of nitrogen.

On May 1, 1989, DOE issued a Program Opportunity Notice (PON) for Round III of the CCT program, soliciting proposals to conduct cost shared CCT projects to demonstrate innovative, energy-efficient clean coal technologies that are capable of being commercialized in the 1990's. These technologies must be capable of: 1) achieving significant reductions in the emissions of sulfur dioxide and/or oxides of nitrogen from existing facilities to minimize environmental impacts such as transboundary and interstate pollution, and/or 2) providing future energy needs in an environmentally acceptable manner. The "Commercial Demonstration of the NOXSO SO₂/NO_x Removal Flue Gas Cleanup System" was selected from among the 48 proposals received by DOE in response to the PON.

To comply with the environmental review requirements of the National Environmental Policy Act (NEPA), the CCT Demonstration Program has developed a three-level strategy that is consistent with the Council of Environmental Quality (CEQ) regulations for implementing NEPA and DOE regulations for compliance with NEPA. The strategy includes the consideration of

both programmatic and project-specific environmental impacts during and subsequent to the project selection process. For the first level of environmental review, DOE prepared a Programmatic Environmental Impact Statement (PEIS). The PEIS, issued by DOE as a public document in November 1989 (DOE/EIS-0146), addressed the potential environmental consequences of the widespread commercialization of each of 22 successfully demonstrated clean coal technologies in the year 2010. The PEIS evaluated: 1) a no-action alternative, which assumed that the CCT Demonstration Program was not implemented and that conventional coal-fired technologies with flue gas desulfurization controls were used for new plants or as replacements for existing plants that were retired or refurbished, and 2) a proposed action, which assumed that CCT Demonstration Program projects were selected for cost-shared funding support and that successfully demonstrated technologies underwent widespread commercialization by 2010.

At the second level of environmental review, a confidential pre-selection project-specific environmental review was prepared for each of the proposals submitted under CCT Round III that were determined to be suitable for comprehensive evaluation. This review summarized for the Source Selection Official the strengths and weaknesses of each specific project relative to the environmental evaluation criteria including, to the maximum extent possible based upon the information provided in the proposal, a discussion of alternative sites and technologies reasonably available to the proposer, a brief discussion of the potential environmental impacts of each proposal, necessary mitigative measures, and a list of known permits and licenses which must be obtained to implement the proposal.

The third element of DOE's NEPA strategy provides for the preparation and public distribution of site-specific NEPA documents for each of the projects selected for proposed financial assistance under the PON. In accordance with NEPA, an Environmental Assessment (EA), which provides a site-specific analysis of the potential environmental impacts of the proposed federal action, will be developed by DOE. This EA will result in either a Finding of No Significant Impact or a determination that significant impacts may occur and that an Environmental Impact Statement (EIS) must be prepared. The sources of information for this EA include the technical proposal for the project submitted by NOXSO Corporation to DOE in response to the CCT Round III PON; discussions with NOXSO and their environmental consultants; discussions with federal and state agencies; this Environmental Information Volume (EIV) for the project provided by NOXSO to the DOE; and visits to the host site.

The scope of the EA includes consideration of: 1) the nature and extent of proposed construction, installation and operational activities; 2) changes in emissions, effluents and wastes that would be generated; and 3) changes in resource requirements.

The proposed federal action is for DOE to provide, through a cooperative agreement with NOXSO, cost-shared funding support for the design, construction and demonstration of an advanced flue gas cleanup technology project, the "Commercial Demonstration of the NOXSO SO₂/NO_x Removal Flue Gas Cleanup System". The NOXSO process would be demonstrated at Alcoa Generating Corporation's (AGC) Warrick Power Plant (WPP) in Warrick County,

Indiana. Elemental sulfur produced at WPP would be shipped to the Olin Charleston Plant (OCP) in Charleston, Tennessee for conversion into liquid SO₂.

Successful future application of the proposed demonstration project could result in reduced SO₂ and NO_x emissions from both new and existing coal-fired plants. The Clean Air Act (CAA), as amended in 1990, instigates the implementation of a market-based approach for the control of SO₂ emissions designed to result in very significant reductions (by about 9 million tons by 2000, down from 1980 levels of around 26 million tons). The CAA also supports the incentives for CCT demonstration projects funded through DOE. Future use of such technologies could help contribute to the attainment of post-2000 air quality standards for SO₂ and NO_x. The CCT Demonstration Program, in concert with the CAA, encourages and assists in the development of clean-burning coal technologies for electrical generating plants. SO₂ emissions reduction is being pursued to meet post year-2000 air quality standards.

The proposed flue gas cleanup technology was identified as a project which, if successfully demonstrated at large-scale commercial operation, would assist utilities in achieving SO₂ emission reductions. Reductions in the emissions of SO₂ and NO_x, National Ambient Air Quality Standards (NAAQS) criterion air pollutants, would be achieved by flue gas cleanup without negatively impacting utility boilers or producing large quantities of waste by-products. This would provide utilities with another option to meet CAA requirements in addition to the use of as-mined low sulfur coal or modifications such as flue gas treatment by waste-producing scrubbers. Accordingly, the proposed demonstration of this technology has the potential to contribute significantly toward achieving the objectives of the CCT Demonstration Program.

Additionally, the objective of the proposed demonstration of this technology is consistent with the U.S. Environmental Protection Agency (EPA) pollution prevention strategy for federal agency activities. The intent of EPA's pollution prevention initiative is to reduce the amount and/or toxicity of pollutants being generated, thereby reducing the environmental impacts of man's technological activities.

1.2 Document Layout

The NOXSO Demonstration Project (NDP) consists of three components: the NOXSO Process, a Sulfur Recovery Unit (SRU), and a Liquid SO₂ Unit. The NOXSO Process and SRU will be located in Indiana while the Liquid SO₂ Unit will be located in Tennessee. Each project location will be reviewed separately; NDP in Indiana, Sections 2-5 and the liquid SO₂ plant in Tennessee, Sections 6-9. Each project location will have the following sections: Proposed Action and Alternatives (a site description of the proposed action, an engineering description of the proposed action and alternatives), Existing Environment, Consequences Of The Project (the environmental and socioeconomic impacts of the construction and operation of the project), and lastly, Applicable Regulations (the applicable Federal, State, and Local regulations).

2 PROPOSED ACTION AND ALTERNATIVES

The purpose of the proposed action is to demonstrate the NOXSO flue gas treatment system in a fully integrated commercial scale operation. The proposed action is designed to reduce sulfur dioxide (SO_2) and nitrogen oxides (NO_x) emissions from Warrick Power Plant (WPP) Unit 2, a 144-MWe coal-fired steam electric generating unit. Unit 2 is one of four units at Alcoa Generating Corporation's (AGC) Warrick Power Plant. The process would be located due south of WPP Unit 2 and would require about an acre of land. The process is designed to achieve 98% SO_2 and 75% NO_x instantaneous removal efficiencies. Additionally, the removed sulfur species are processed into salable liquid sulfur. A liquid sulfur dioxide plant, covered in Sections 6-9 of this document, will be constructed at a different site to process the liquid sulfur into liquid sulfur dioxide.

The NOXSO Process technology has been successfully proven in laboratory and bench scale applications. In addition, over 6500 flue gas hours were logged at the since completed pilot-scale five megawatts (MWe) Proof-of-Concept (POC) project at the Ohio Edison Toronto Power Station in Toronto, Ohio. The final POC report is finished and is available in the public domain. Data from the POC will be used in the design of this demonstration facility.

This section presents information covering the site description of the proposed action and the engineering description of the proposed action and alternative sites.

2.1 Site Description of the Proposed Action

The description of the WPP site is presented in the following sub-sections. The first sub-section describes the general location of WPP. The second and third sub-sections provides a detailed description of WPP (host plant site) and existing plant operating conditions. Sub-sections four and five review existing environmental considerations and resource requirements, respectively.

2.1.1 Existing Facility

The WPP is owned by AGC and operated by the Southern Indiana Gas and Electric Company (SIGECO). The plant supplies electricity to Alcoa's adjacent Warrick Operations aluminum facility and to the utility grid. The WPP consists of three coal-fired steam electric generating units (Units 1, 2, and 3), each rated at 144-MWe, and Unit 4, rated at 300-MWe. Unit 4 is jointly owned by AGC and SIGECO. Approximately 80% of the electric power generated is used by Warrick Operations, with the remainder being sent to the utility grid.

2.1.2 General Location

As shown in Figure 2-1, the WPP is located in Warrick County, about 15 miles east of Evansville, Indiana, on Indiana Route 66. Yankeetown, Indiana, the closest town to the project, is about two miles northeast of the plant. The WPP facility address is Post Office Box 10, Newburgh, Indiana 47629.

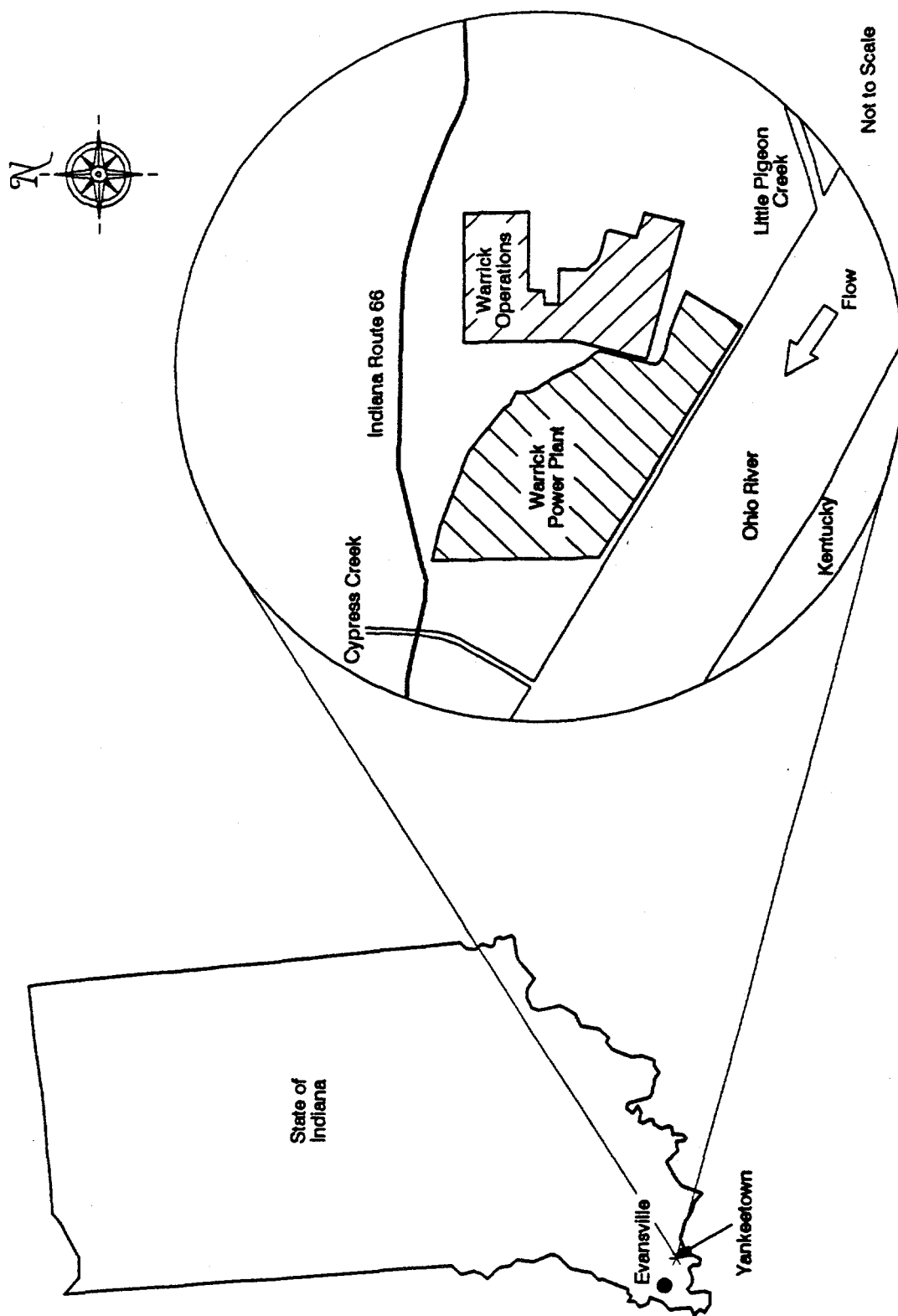


Figure 2-1. Warrick Power Plant and Warrick Operations Site Location

The WPP and Warrick Operations consist of approximately 600 acres between Indiana Route 66 and the Ohio River. A plant map of the Alcoa facility is shown in Figure 2-2. Two other industrial sites are nearby. Adjacent to the Alcoa industrial complex, on the up stream side, is SIGECO's Culley power plant. The Culley power plant has three coal-fired steam electric generating units producing about 415-MWe total. The Yankeetown Dock Corporation is located about 3/4 of a mile upstream from the WPP. The Yankeetown Dock Corporation transports coal by rail to a barge loading facility.

The sparsely populated area surrounding this industrial area is used for farming, animal pasture, and orchards. Agricultural uses include growing corn, soybeans, alfalfa, some grains, and tobacco. Coal strip-mining activities in this area have disturbed some of the natural topography.

2.1.3 WPP Site and Existing Plant Operating Conditions

All four units at the WPP are currently fired with coals blended to not exceed the Warrick County State Implementation Plan (SIP) limit of 5.11 pounds (lb) SO₂ per million British thermal units (mmBtu) of heat input. Low sulfur Appalachian coals are delivered by truck and barge to the WPP. High sulfur Squaw Creek coal is delivered by rail from a nearby Indiana mine. The composition of the Squaw Creek coal and of two representative low sulfur coals is shown in Table 2-1. The WPP coal storage facility is shown in Figure 2-3. A 90-day inventory of coal is kept by the WPP. Coal is fed by conveyor to pulverizers, and the feed rate to Unit 2, where the NOXSO Process will be installed, is about 60-65 tons per hour.

AGC intends to opt-in WPP Units 1, 2, and 3 to the Acid Rain Program of the Clean Air Act (CAA) Amendments of 1990. The Opt-In Program (40 CFR Part 72) allows nonaffected sources, like AGC's WPP Units 1, 2, and 3, to enter the SO₂ portion of the acid rain program and receive SO₂ emission allowances. The opt-in program covers only SO₂ and not the other compounds covered under the CAA. Units 1, 2, and 3 will not be bound by the CAA Title IV NO_x regulations.

Unit 2 will also have natural gas co-fire capabilities prior to installation of the NOXSO Process. Co-firing allows the unit to use natural gas for up to 20% of its heat input. Upon the installation of the NOXSO Process, Unit 2 will be fired exclusively with unblended Squaw Creek coal or a similar high sulfur coal.

Unit 4 is an affected Phase I source under the CAA and as such will be limited to SO₂ emissions of no greater than 2.5 lbs/mm Btu starting in January 1996. Compliance strategy for this Unit has not been finalized at this time.

2.1.3.1 Unit 2

As noted above, the NOXSO Process will be installed on Unit 2 at the WPP. Figure 2-4 shows flue gas flows from Units 1, 2, and 3. As shown, all flue gas passes through an electrostatic precipitator (ESP) for particulate control. The chimneys are 400 feet (ft) tall and have an inside tip diameter of 15.3 ft.

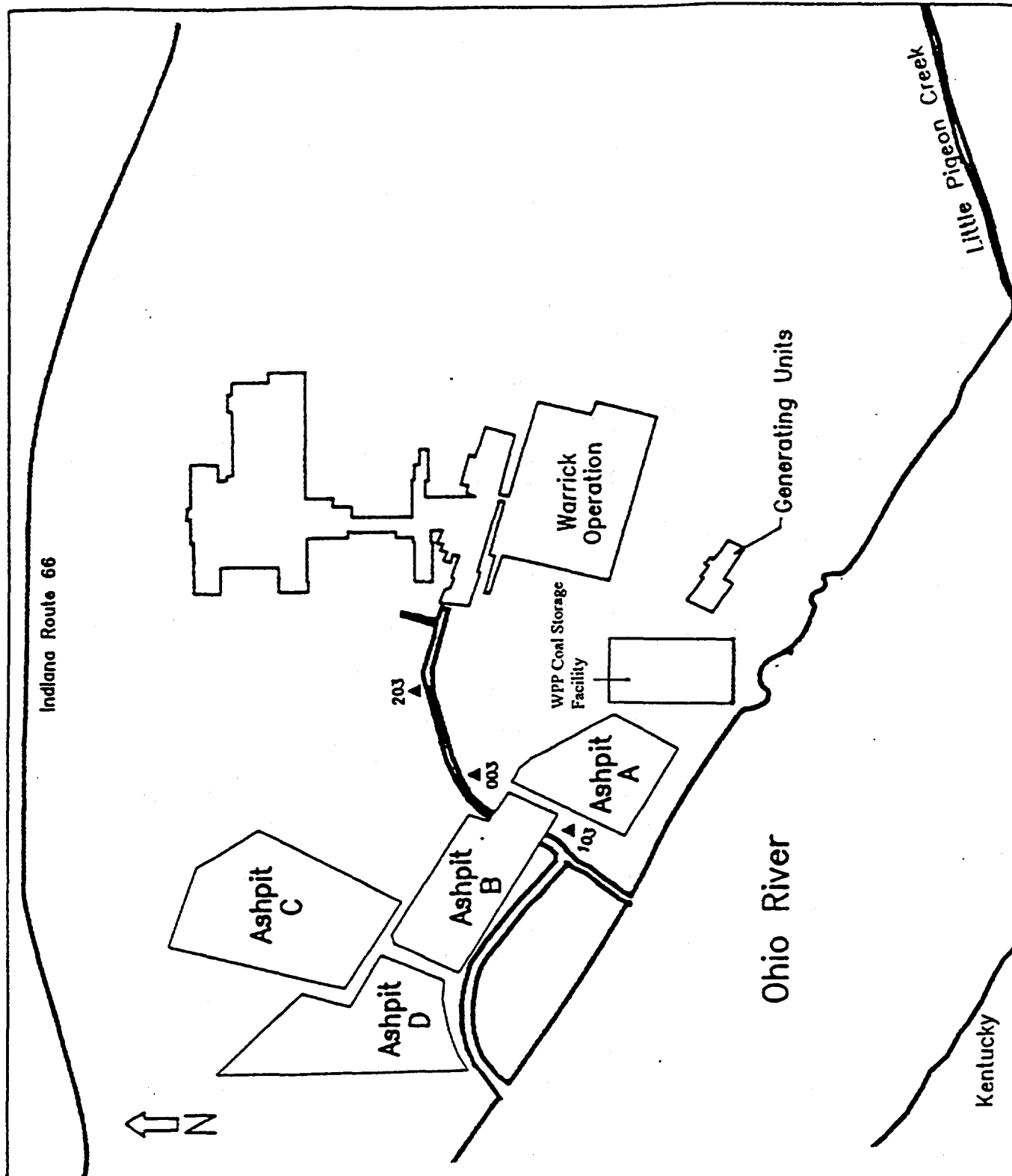


Figure 2-3. WPP Coal Storage Facility

Table 2-1 Coal Composition - Ultimate Analysis

Parameter	Weight Percent (%)		
	Squaw Creek	West Virginia	Kentucky
Moisture	12.92	7.00	5.63
Carbon	62.02	74.65	73.08
Hydrogen	4.58	5.03	4.68
Nitrogen	1.22	1.33	1.25
Chlorine	0.05	0.07	0.07
Sulfur	3.39	0.73	0.83
Ash	8.23	7.51	8.78
Oxygen	7.60	3.68	5.67
Higher Heating Value (HHV) (Btu/lb)	11,307	13,240	12,613
Source: Alcoa			

Table 2-2 shows the design parameters for Unit 2. The wall-fired unit built by Babcock & Wilcox Company (B&W) was placed in service in 1964. The boiler is a natural circulation, Carolina-type radiant unit with 16 circular coal burners arranged in a 4-by-4 grid on a single furnace wall. Coal is reduced from 3/4 inches (in) to 60% less than 200 mesh by B&W EL-76 ball and race pulverizers.

2.1.4 Environmental Considerations

2.1.4.1 Squaw Creek Coal

The high sulfur coal used by WPP is produced by the Squaw Creek Coal Company (SCCC). SCCC is a joint venture between Alcoa and Peabody Coal Company. The strip mine is located about 15 miles north of WPP near Booneville, Indiana.

Squaw Creek has about 4 million tons of economically recoverable surface reserves. Alcoa currently estimates these reserves will be mined out in 1998. However, the possibility of reducing the volume from the mine to a substantially lower rate, which would naturally increase the life of the surface mine, is being investigated. The mine also has about 40 million tons of recoverable underground reserves; however, mining these underground reserves is not economically competitive with the current high sulfur coal market. The surface mine will be operated until the economically recoverable surface reserves are exhausted.

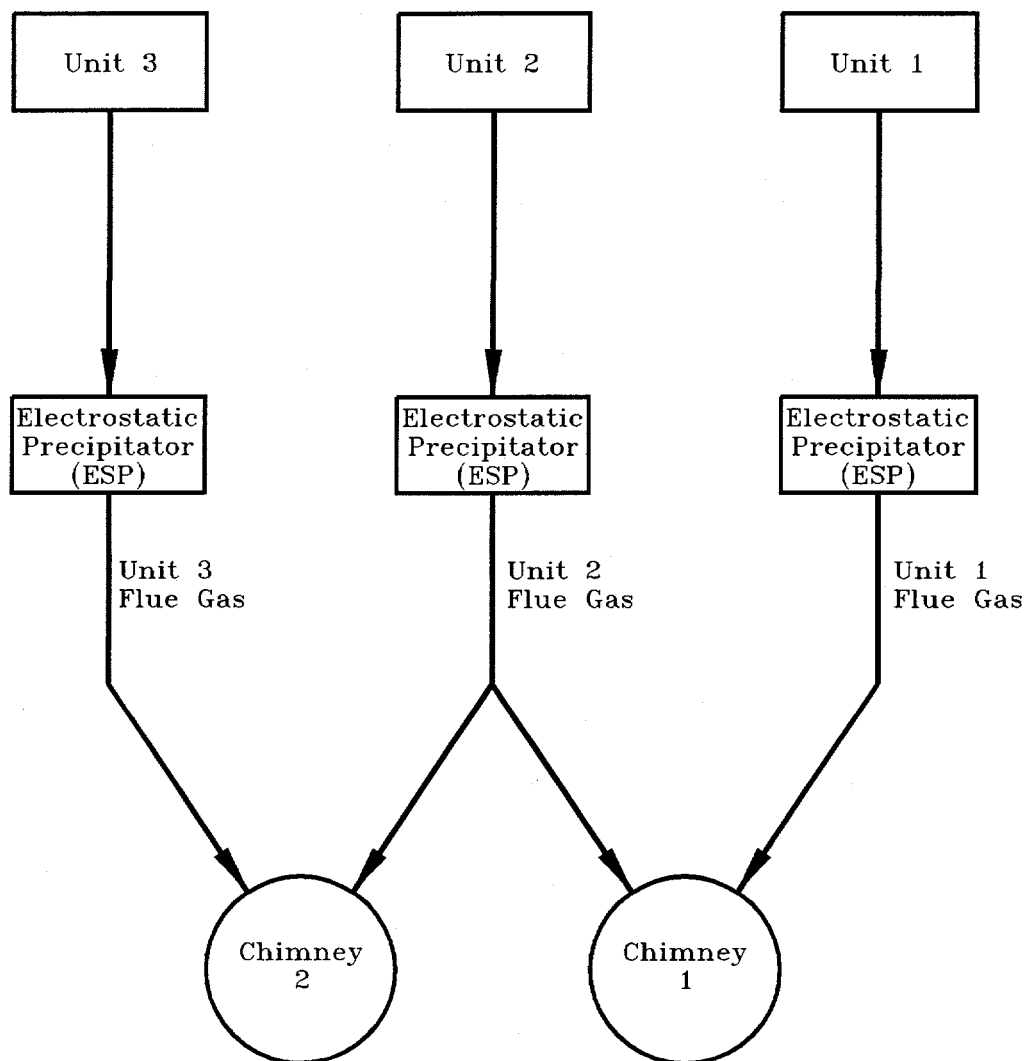


Figure 2-4. Flue Gas Flows, Units 1, 2, and 3

Table 2-2 Unit 2 Design Parameters

Boiler Manufacturer	Babcock & Wilcox
Operation Date	1964
Primary Fuel	Coal
Start-up Fuel	oil (gas with co-fire)
Boiler Type	wall-fired, natural circulation, Carolina-type radiant unit
Nameplate Rate	144 MW
Steam Flow	1,000,000 lb/hr
Steam Temperature	1,005°F
Design Pressure	1,975 psig
Turbine/Generator Set	160 MW
Existing Burners	16 wall-fired burners
Particulate Control	Western Precipitator electrostatic precipitator designed for 1.83 grains/acfm outlet dust for 688,600 acfm flue gas at 710°F
Source: Alcoa	

2.1.4.2 Existing Air Emissions

Available 1993 air emissions data for the WPP are as follows: 125,026 tpy SO₂, 22,461 tpy NO_x and 1,698 tpy PM. These numbers are annual averages of values submitted on compliance reports to the Indiana Department of Environmental Management (IDEM) in 1993.

2.1.4.3 Water Use and Wastewater Discharge

This section discusses water use and wastewater discharge associated with the WPP. As a high-capacity surface water and groundwater user [$> 100,000$ gallons per day (gpd)], the WPP is required by the 1983 Indiana Water Resource Management Act to report annual surface water use to the Natural Resource Commission through the Indiana Department of Natural Resources (IDNR), Division of Water (Ref. 1).

Water Use

Surface water used by the WPP facility is diverted from the Ohio River via eight intake pumps. River water is used primarily for once-through cooling purposes and ash sluicing at the WPP. In 1993, the WPP diverted an average of 444 million gallons per day (mgd); all of which was returned to the Ohio River, excluding minor evaporative losses. The WPP's annual surface

water withdrawals from the river for the five-year period of 1989-1993 are shown in Table 2-3 were (Ref. 2):

Table 2-3 WPP's Annual Surface Water Withdrawals

Year	Million of Gallons
1989	133,000
1990	138,000
1991	142,000
1992	148,000
1993	162,000

Groundwater for the WPP is obtained from six on-site deep-water wells. These wells have a capacity of 17 mgd. Approximately 6 mgd of deep-well water are treated for iron and manganese removal, and then filtered and chlorinated. This treated water is used as potable and process water at both the WPP and Warrick Operations. In 1993, the WPP used about 1.06 mgd of groundwater, while Warrick Operations used 3.74 mgd. Annual groundwater data available from the IDNR, shown in Table 2-4, reflects combined WPP and Warrick Operations groundwater use (Ref. 3):

Table 2-4 Annual Groundwater Data

Year	Millions of Gallons per Day
1989	6.4
1990	5.9
1991	5.6
1992	5.4
1993	4.8

Wastewater Discharge

Both the WPP and Warrick Operations operate under a single National Pollutant Discharge Elimination System (NPDES) permit (No. IN0001155) issued by the IDEM, Permits Section, Office of Water Management. The five permitted outfalls associated primarily with the WPP are outfalls 001, 002, 004, 005, and 103 (Ref. 4). Figure 2-5 shows the outfall locations for the WPP and Warrick Operations. Figure 2-6 is an outfall discharge schematic for the power plant (Ref. 3). Table 2-5 describes the wastewater streams discharged through each outfall, the wastewater treatment method, and the average daily discharge flow.

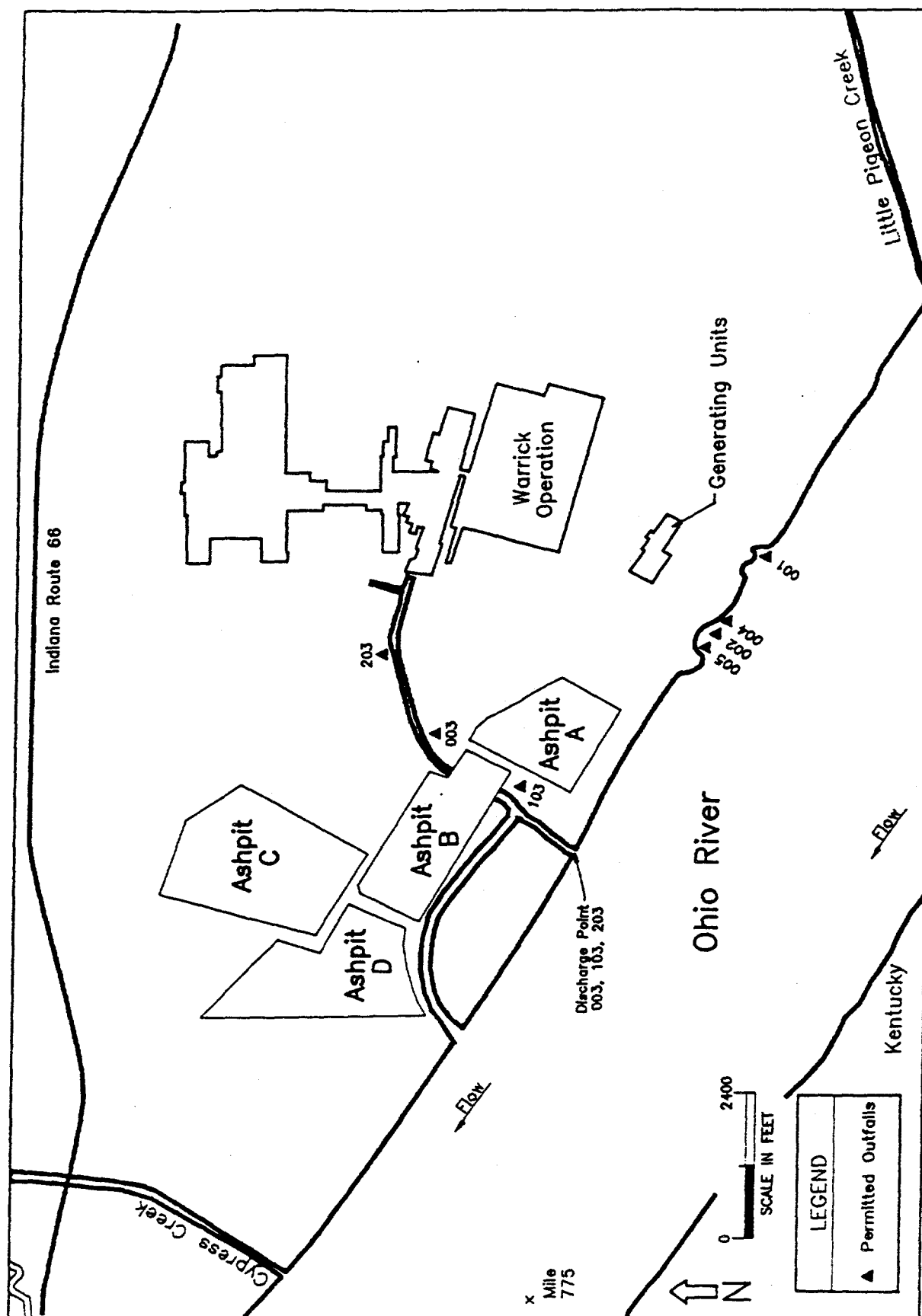


Figure 2-5. Outfall Locations, Warrick Power Plant and Warrick Operations

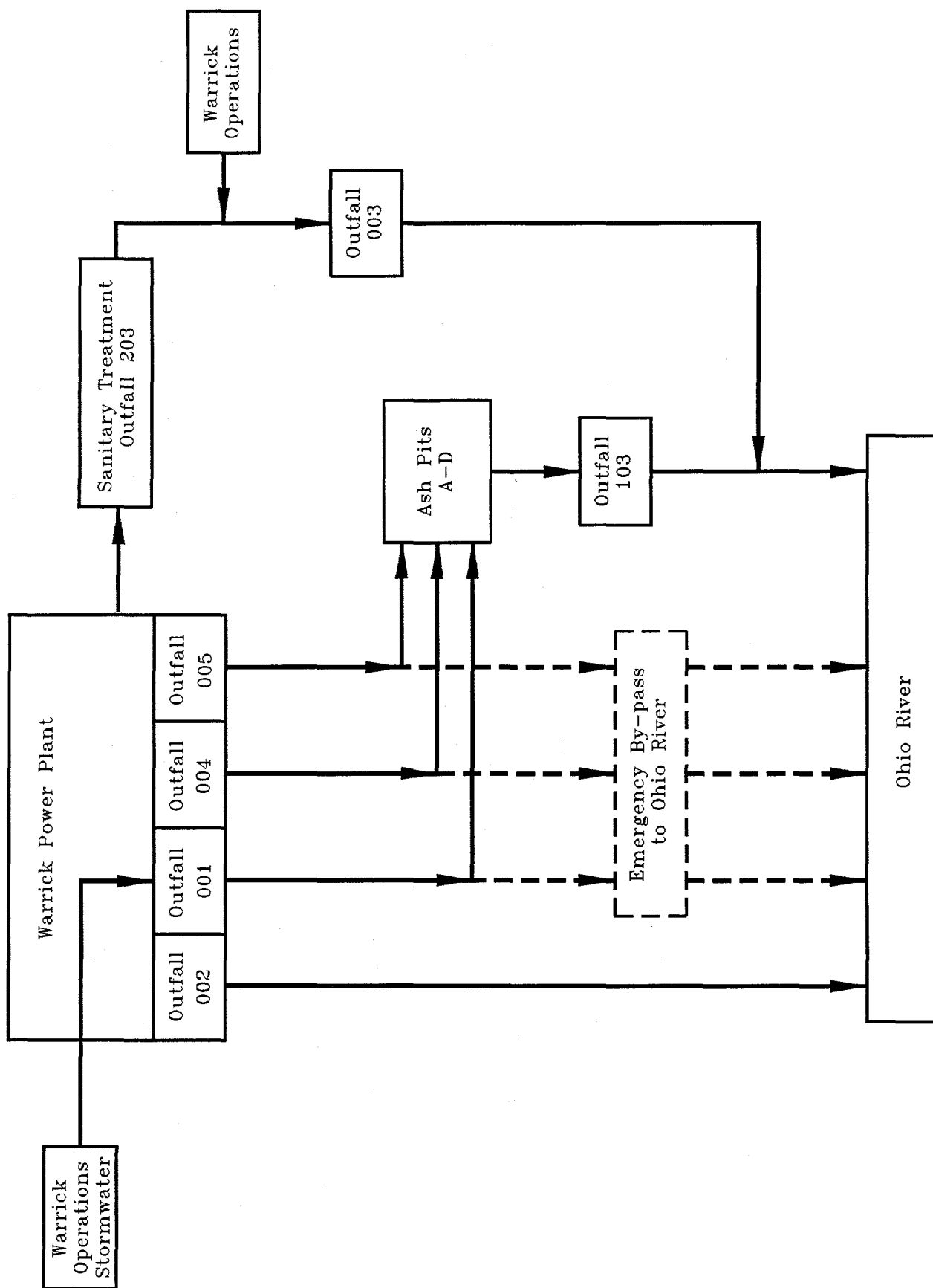


Figure 2-6. Outfall Discharge Schematic for Warrick Power Plant

Table 2-5 Description of Outfalls, Treatment, and Average Flows

Outfall No.	Outfall Description	Treatment	Average Flow (mgd)
001	Lift station that collects combined storm water runoff from Warrick Operations and the WPP, power plant cooling water except condenser cooling water.	None. Pumped to fly ash pit.	0.3 - 0.5
002	Once-through condenser cooling water from WPP operations. This water is taken directly from the Ohio River.	Chlorinated.	300 - 450
003	Warrick Operations main plant discharge including process water, noncontact cooling water, effluent from wastewater treatment operations, and storm water runoff.	None.	4.23
103	Fly ash pit system discharge effluent includes coal pile run-off water and a mixture of ash and water from fly ash and bottom ash from the collecting hoppers in the power plant that is conveyed and discharged into the fly ash pit system. The fly ash pit system and wastewater from demineralization unit for both WPP and Warrick Operations.	All waters entering the fly ash pit system undergo solids settling and pH adjustment prior to discharge.	9.22
203	Activated sludge sanitary treatment facility. Serving both Warrick Operations and the WPP.	Extended aeration followed by disinfection with chlorine between April 1 and October 31.	0.178
004	Lift station that collects a major portion of the water from power plant surface and floor drains, ash sluice pits, trenches, and cooling water.	None. Pumped to fly ash pit system.	0.65 - 0.85
005	Lift station that collects water from the power plant yard areas including the coal pile, once-through cooling water from the ore unloading dock, and storm water run-off collected in some field drains around the rail car coal unloading area.	Lift station pumps all water to the fly ash pit system where solids settling and pH adjustment occur prior to discharge at Outfall 103.	0.07 - 0.15

Source: NPDES Renewal Permit No. IN0001155 for Alcoa - Warrick Operations, February 26, 1990.

Under normal conditions, Outfalls 001, 004, and 005 serve as pumps that pump water to the fly ash pit system. During heavy rainfall events, these outfalls overflow and are directly discharged to the Ohio River. Outfalls 001, 004, and 005 are monitored only during overflow conditions. Outfall 001 is monitored for flow, pH, total suspended solids (TSS), oil and grease (O&G), and total iron. Outfall 004 is monitored for flow, pH, TSS, O&G, total lead, total nickel, and total zinc. Outfall 005 is monitored for the same parameters as Outfall 001. (Ref. 4)

Outfall 002 discharges water associated with the once-through main condenser noncontact cooling water system at the WPP. This outfall discharges directly to the Ohio River. Outfall 002 is monitored with grab sampling three times per week for flow, pH, and total residual chlorine (TRC). (Ref. 4)

Outfall 103 receives water from the fly ash pit system. Wastewater from Outfall 103 includes coal pile runoff, ash sluicing, bottom ash water from the collecting hoppers, storm water, and the demineralization unit's wastewater. Wastewater from Outfall 103 merges with wastewater from the Warrick Operations Outfall 003 at a point downstream from the fly ash pit system and discharges directly into the Ohio River. Monitoring is conducted at Outfall 103 before its confluence with the Warrick Operation's wastewater. Outfall 103 is monitored two times per week for flow, pH, TSS, and O&G. It is also monitored for total iron and total copper during times of boiler cleaning, if cleaning wastewater is discharged to the fly ash pit system. (Ref. 4)

Outfall 203 receives the discharge from the sanitary effluent treatment plant for Warrick Operations and the WPP. Outfall 203 is an internal outfall. Wastewater passes through Outfall 003 and then merges with flow from Outfall 103 prior to its discharge into the Ohio River. Outfall 203 is monitored two times per week for flow, pH, and five-day biochemical oxygen demand (BOD₅). The NPDES permit requires that TRC be monitored during the months of April through October (inclusive) because the Ohio River is available for full-body contact recreation. (Ref. 4)

2.1.4.4 Solid and Liquid Waste

Fly ash and bottom ash, about 55,000 lbs/hr, are managed in the on-site NPDES-permitted ash pond system. Fly ash and bottom ash are sluiced in above-ground pipelines to the ash ponds. The ash ponds are dredged when full and the material is used to increase the ponds' berm height. All fly ash and bottom ash from the ash pond system remains on site. The chemical composition of both the fly ash and bottom ash is shown in Table 2-6.

All other waste materials are managed at permitted off-site facilities. Nonhazardous wastes include general trash (wood, packaging materials, paper, etc.) and waste (including waste oil, empty drums, scrap metal, etc.) from construction, operation, and maintenance activities. Hazardous wastes include asbestos, paint and solvents from maintenance activities and occasional boiler cleaning wastes. WPP is normally a small quantity generator; during 1993 147 gallons of waste solvent was generated. WPP becomes a large quantity generator for one month a year when the boilers are cleaned. Boiler cleaning generates about 70,000 gallons of chelant water. The WPP EPA waste disposal ID number is IND049940307.

Table 2-6 Ash Analysis

Constituent	Fly Ash ⁽¹⁾ wt %	Bottom Ash ⁽¹⁾ wt %
Silicon as SiO ₂	45.30	41.27
Aluminum as Al ₂ O ₃	19.30	17.59
Iron as Fe ₂ O ₃	22.30	27.38
Calcium as CaO	6.63	9.01
Magnesium as MgO	0.82	0.79
Sodium as Na ₂ O	0.51	0.37
Potassium as K ₂ O	2.11	1.66
Titanium as TiO ₂	1.04	0.89
Phosphorus as P ₂ O ₅	0.38	0.30
Sulfate as SO ₃	1.54	0.65
Manganese as MnO	0.08	0.09
(1) 100% Squaw Creek coal		

2.1.4.5 Public Participation

The purpose of this section is to provide information for the DOE's public involvement in the DOE/NEPA process. The draft plan is to announce in the local media that DOE is preparing a NEPA document for this project and all interested parties are invited to contact DOE at a toll-free phone number. The interested parties will be able to leave recorded comments at this phone number. The DOE will respond to these comments and these comments will be taken into consideration in the NEPA documents.

The major newspapers and their circulation areas include the following:

- **The Evansville Courier**, morning daily with a tri-state circulation area
- **The Evansville Press**, afternoon daily distributed primarily in Vanderburgh and Warrick Counties.
- **The Henderson Gleaner**, community paper in Henderson, Ky.
- **The Messenger-Inquirer**, community paper in Owensboro, Ky.

The major television and radio stations in the area include the following:

- **WIKY-104FM**
Format: radio news focused on Vanderburgh and Warrick counties
- **WFIE-Ch14**
Affiliation: NBC
- **WEHT-Ch7, CBS**
Affiliation: CBS
- **WTVW-Ch44**
Affiliation: FOX

2.1.5 Resource Requirements

WPP resource requirements for 1993 are summarized in Table 2-7.

2.1.5.1 Coal

In 1993, a total of 2,481,863 tons of coal was consumed by the WPP. Of this total Unit 2 consumed 527,649 tons.

2.1.5.2 Fuel Oil

In 1993, a total of 71,028 gallons of oil was used to light off Units 2 and 3.

2.1.5.3 Natural Gas

In 1993, a total of 809,592 MCF was consumed by the WPP. Natural gas was used to light off Units 1 and 4. Unit 1 was also cofired with natural gas.

2.1.5.4 Water

In 1993, an average of 1.06 mgd of ground water and 444 mgd of surface water was used by the WPP. Of this total Unit 2 consumed 93.6 mgd of surface water and 0.18 mgd of ground water.

2.1.5.5 Electrical Power

In 1993, a total of 339,706 MWH was consumed by the WPP. Of this total Unit 2 consumed 73,352 MWH.

2.1.5.6 Labor

WPP is operated by about one hundred and eighty SIGECO employees.

2.1.5.7 Land

The WPP and Warrick Operations comprise about 600 acres.

Table 2-7 1993 Warrick Power Plant Resource Requirements

	Units	WPP Facility	Unit 2
Coal	tpy	2,481,863	527,649
Fuel Oil	gal/yr	71,028	46,612
Natural Gas	mcf/yr	809,592	0
Water			
Surface	mgd	444	93.6
Ground	mgd	1.06	0.18
Electricity	MWhr/yr	339,706	73,352
Labor	# of people	180	NA
Land ⁽¹⁾	Acres	600	NA

(1) Alcoa facility including WPP and Warrick Operations

2.2 Engineering Description of Proposed Action

This project is the last step in the commercialization of the NOXSO Process. The NOXSO demonstration project (NDP) will provide both background data for further optimization of process systems and additional information for future scale-up and installation.

The following section presents a summary of the NDP. Subsequent sections detail the unit operations which comprise this technology, the major phases and schedule of the NDP, installation/construction activities, project source terms, and potential Environmental, Health, Safety and Socioeconomic (EHSS) effects on the work force and general public and project resource requirements.

2.2.1 The NOXSO Demonstration Project

The NDP consists of three components, the NOXSO Process, a Sulfur Recovery Unit (SRU), and a Liquid SO₂ Unit. The NOXSO Process and SRU will be located on about an acre of WPP property immediately south of Unit 2. The area is a previously disturbed, unvegetated construction site and is readily available for construction of the NDP. Figure 2-7 presents the site plan for the NDP, detailing the relationship of the NOXSO Process and SRU to WPP's Units 1-3. The Liquid SO₂ Unit will be located in Charleston, Tennessee, and will be discussed in Sections 6-9 of this document. The NDP, when referred to in this section, and in sections 3-5, includes only the NOXSO Process and SRU located at the WPP in Warrick County, Indiana.

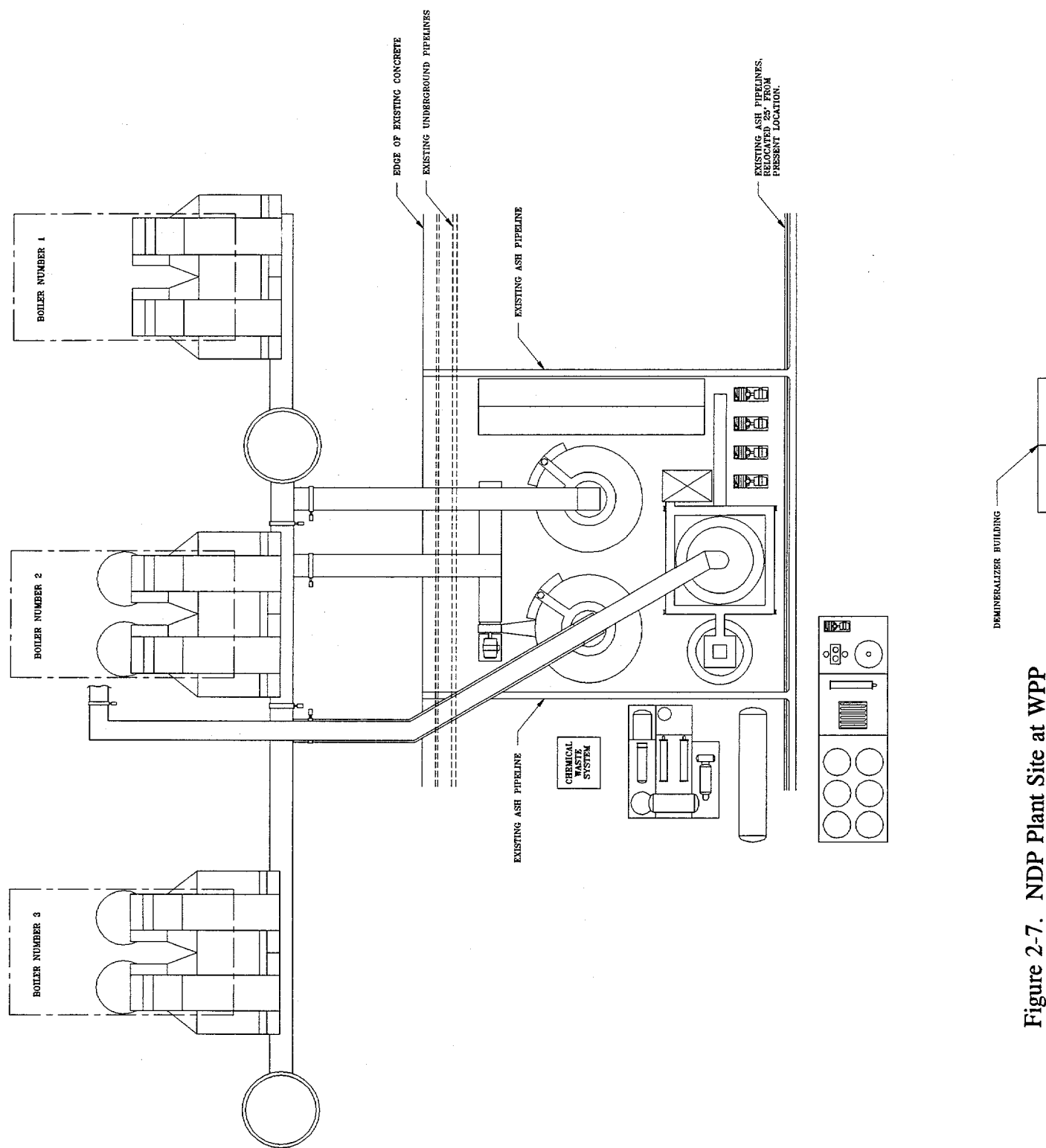


Figure 2-7. NDP Plant Site at WPP

The NOXSO Process, the primary aspect of the NDP, is an advanced flue gas treatment system designed to control emission of the primary precursors to the creation of acid rain, SO_2 and NO_x . In the basic process, as presented in Figure 2-8, flue gas from the Unit 2 ESP passes through a fluidized bed adsorber containing NOXSO sorbent. The NOXSO sorbent is a high surface area, gamma-alumina bead containing 5.2% by weight sodium (Na). Fresh NOXSO sorbent and several key resources (water, air, and natural gas) are continuously fed to the process. The process in turn produces three outputs: 1) a clean flue gas stream which passes to the stack, 2) a NO_x laden gas stream which is recycled back to the Unit 2 burner, and 3) a regenerator off-gas stream primarily containing hydrogen sulfide (H_2S), SO_2 , and carbon dioxide (CO_2). The NOXSO Process is expected to achieve instantaneous SO_2 reductions of 98% and NO_x reductions of 75%.

The second component, the SRU, receives the regenerator off-gas stream from the NOXSO Process and contacts it with an alumina catalyst to produce elemental sulfur. The SRU hydrogenates a portion of the incoming SO_2 to form H_2S , which is then reacted with the remaining SO_2 to produce molten sulfur. The SRU requires inputs of air, boiler feed water, and natural gas, and produces, in addition to the elemental sulfur, the following three outputs: 1) steam which is fed into the NOXSO Process, 2) water, and 3) a tail gas which is recycled back to the feed side of the NOXSO Process.

2.2.1.1 The NOXSO Process

The NOXSO Process is a dry, regenerable system capable of removing both SO_2 and NO_x from flue gas generated by coal-fired utility boilers. A simplified process flow diagram of the NOXSO Process is shown in Figure 2-9. Major process flow streams are indicated on the process flow diagram by the numerical labels. The following discussion reviews the major unit operations and references these labels.

Adsorption

Particulates are removed from the Unit 2 flue gas stream prior to the ID fan by an existing hot side electrostatic precipitator. The flue gas entering the NOXSO Process is taken off downstream of the Unit 2 ID fan (Stream 1). The gas passes through a fluidized bed adsorber containing the NOXSO sorbent. As the flue gas passes through the fluidized bed, SO_2 and NO_x are simultaneously removed. The fluid bed temperatures are controlled by spraying water directly onto the bed. The water spray volume is small compared to the flue gas stream (~5%) and the water is vaporized instantaneously in the flue gas stream occupying the fluid beds. No waste water is generated.

The adsorber is sized based on both the flue gas volumetric flow rate and the required fluidization design velocity of 2.8 fps. Current design anticipates that two adsorbers, with a total cross-sectional area of about 3,300 ft^2 , will be required. Prior to its return to the stack, the flue gas passes through a baghouse which removes entrained particulates, both attrited sorbent and flyash. The cleaned flue gas, which contains several chemical constituents (N_2 , O_2 , CO_2 , H_2O , SO_2 , NO), and a small amount of ash and attrited NOXSO sorbent, is returned to

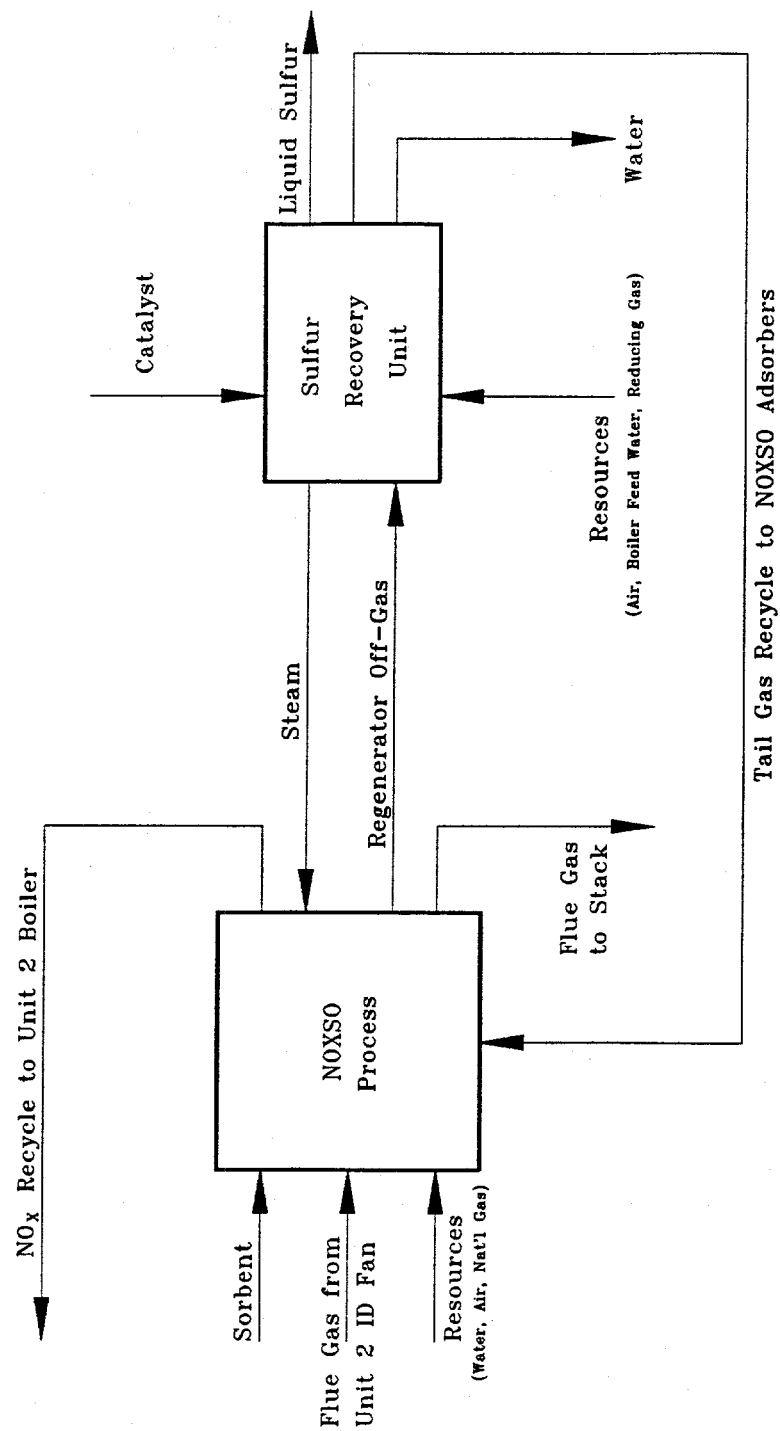


Figure 2-8. Primary Components of the NOXSO Demonstration Project

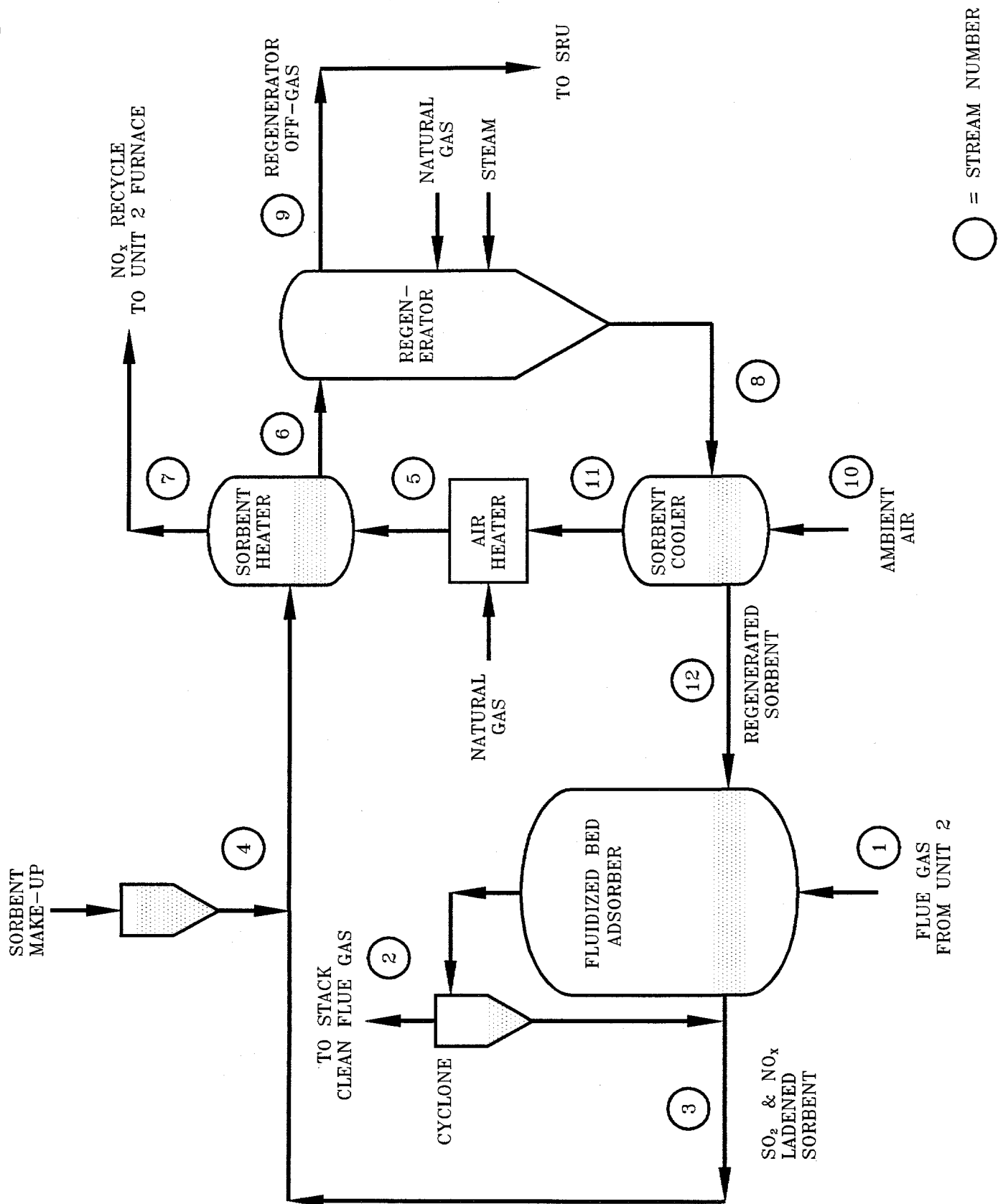


Figure 2-9. Simplified NOXSO Process Flow Diagram

the duct downstream of the NOXSO Process breaching and then exits through the stack (Stream 2).

NOXSO Sorbent Heater

Sorbent saturated with SO_2 and NO_x continuously flows from the adsorber (Stream 3) and is combined with makeup NOXSO sorbent (Stream 4) before being pneumatically conveyed to the NOXSO sorbent heater. The NOXSO sorbent heater is a multi-stage fluidized bed in which a hot air stream (Stream 5) counter-currently contacts the saturated NOXSO sorbent, raising the NOXSO sorbent temperature to $\approx 1150^\circ\text{F}$.

The hot air which enters the NOXSO sorbent heater is heated by a natural gas fired air heater. The air heater uses about 800 SCFM of natural gas and produces the typical products of combustion, CO_2 , H_2O and a very small amount of NO_x . The NOXSO sorbent continuously cascades within the sorbent heater from one stage to the next by means of downcomers that connect each stage. After the final stage the NOXSO sorbent exits the NOXSO sorbent heater and passes on to the regenerator (Stream 6).

The gas stream leaving the NOXSO sorbent heater (Stream 7) contains several chemical constituents (O_2 , N_2 , CO_2 , H_2O , SO_2 , NO_x) and attrited NOXSO sorbent. The air heater products of combustion are unaffected by contact with sorbent in the Sorbent Heater. Since this stream contains all of the NO_x which has been removed by the NOXSO sorbent and is returned to the Unit 2 furnace, it is referred to as the NO_x recycle. The heat from the NO_x recycle stream is used to heat some of the main plant condensate, thereby reducing the amount of steam extracted from the power plants low pressure turbine for this purpose.

Under normal operating conditions, the recycled NO_x will either disassociate to nitrogen (N_2) and oxygen (O_2) or suppress the formation of additional NO_x producing a steady-state equilibrium concentration of NO_x . Empirical data from NOXSO test programs was used to calculate the steady state NO_x concentration after recycle.

Regenerator and Steam Treater

Once the NOXSO sorbent reaches a regeneration temperature of $\approx 1150^\circ\text{F}$, it is transported from the NOXSO sorbent heater to a moving bed regenerator (Stream 6). In the regenerator the NOXSO sorbent is contacted consecutively with natural gas and steam in a counter-current manner. The natural gas reduces the sulfur compounds on the NOXSO sorbent, mainly sodium sulfate (Na_2SO_4), to primarily SO_2 and H_2S . Approximately 10% of the Na_2SO_4 is reduced to sodium sulfide (Na_2S). H_2S is produced from the reaction of steam with the Na_2S .

The off-gas from the regenerator is sent to a SRU (Stream 9) for conversion into elemental sulfur. The regenerated NOXSO sorbent is then conveyed to NOXSO sorbent cooler (Stream 8). No attrited sorbent is carried out with the regenerator off-gas (Stream 9). Attrited sorbent will be entrained in the NO_x recycle stream 7 prior to the sorbents transport to the regenerator.

In addition, the superficial gas velocity in the regenerator is too low to entrain any attrited sorbent particles which may be present.

NOXSO Sorbent Cooler

The regenerated NOXSO sorbent entering the NOXSO sorbent cooler is cooled by contact with ambient air (Stream 10). This contacting both cools the NOXSO sorbent, from a temperature of $\approx 1100^{\circ}\text{F}$ to a temperature of $\approx 325^{\circ}\text{F}$, and provides pre-heated air for the air heater (Stream 11). The cooled, regenerated NOXSO sorbent is then returned to fluidized bed adsorber (Stream 12).

2.2.1.2 Sulfur Recovery Unit

The regenerator off-gas from the NOXSO Process (Stream 9), which contains H_2O , CO_2 , CH_4 , COS , CS_2 , SO_2 , H_2S , and elemental sulfur from NOXSO sorbent regeneration, is processed by the SRU to produce elemental sulfur. The use of sulfur recovery technology, specifically the Claus process, dates back to 1883. There are currently over 100 Claus plants operating in the U.S. today. The SRU will produce about 50 tons/day of molten sulfur. Figure 2-10 presents a basic flow diagram of the SRU. Primary unit operations are numerically labeled on this figure and referenced in the following discussion.

The first step involves generating hydrogen in a reaction furnace (Unit 1) by oxidizing natural gas in substoichiometric ratio in the presence of steam. This hot hydrogen-rich stream, about 2000°F , and the regenerator off-gas, about 1000°F , are cooled to about 600°F by generating steam in a waste heat boiler (Unit 2). The hydrogen-rich stream and a portion of the regenerator off-gas pass through a hydrogen reactor (Unit 3) where the SO_2 in the off-gas is hydrogenated to H_2S . Heat is removed from the hydrogen reactor using a hot oil loop and a heat exchanger (Unit 4) which also produces steam. The gas stream from the hydrogen reactor and the remaining regenerator off-gas are combined, resulting in a gas stream with an H_2S to SO_2 molar ratio of 2:1. After passing through the sulfur condenser (Unit 5), where the heat removed from the gas stream is again used to heat boiler feed water and produce steam, the gas is compressed (Unit 6) and reheated using steam (Unit 7). The gas then passes through a sulfur converter (Unit 8) where H_2S and SO_2 are reacted catalytically to produce elemental sulfur. Sulfur is removed from the gas stream by passing the gas back through the sulfur condenser and the gas stream is reheated and makes another pass through the sulfur converter. The elemental sulfur condensed from the gas stream is stored in a steam heated storage tank (Unit 9). A portion of the steam produced by the SRU is used by the NOXSO Process before ultimately being discharged to the stack. The remaining byproduct gas stream, along with the sweep gas from the sulfur storage tank, flows to a thermal oxidizer (Unit 10) where any fugitive carbonyl sulfide (COS), carbon bisulfide (CS_2), and unreacted H_2S are oxidized to SO_2 . This tail gas stream is then recycled back to the NOXSO adsorbers where the SO_2 , and the small amount of NO_x formed during incineration, is readsorbed from the gas stream.

2.2.2 Project Phases

The NDP will be completed in three primary phases. The following discussion summarizes these phases and a project milestone scheduling chart is shown in Figure 2-11.

2.2.2.1 Phase 1A - Project Definition/Preliminary Design

The project definition and preliminary design phase includes the integration of NOXSO pilot plant test results into the full-scale plant design. Preliminary process flow diagrams, piping and instrumentation diagrams, major equipment specifications, plant layout drawings, cost estimates, project schedules, and the Project Management Plan are prepared in this phase. In addition, other preliminary design work such as engineering optimization studies, site survey, and geotechnical investigation and host site characterization are included. Phase 1A was completed in November 1994, however, DOE approval to proceed to phase 1B was not granted until January 1995.

2.2.2.2 Phase 1B - Front End Engineering/Environmental Evaluation

The front end engineering and environmental evaluation phase includes finalization of all design considerations and preparation of the Environmental Information Volume (EIV) in compliance with NEPA. Engineering drawings will be prepared for the civil/structural design, mechanical design, electrical design, and instrumentation and control systems design. Bid packages will also be prepared and distributed in preparation of awarding construction services. This phase will run about 7 months.

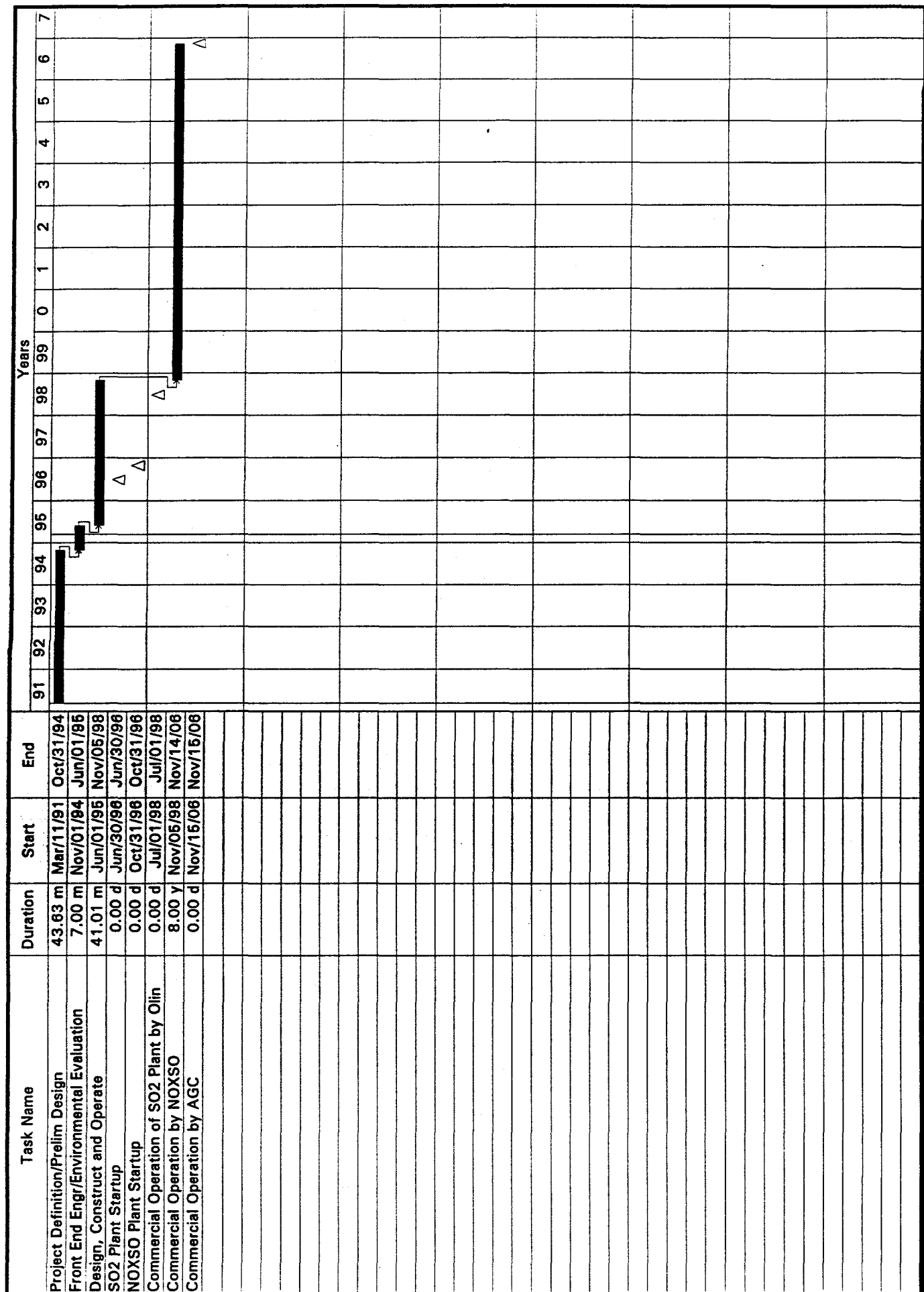
2.2.2.3 Phase 2 - Design, Construction, and Operation

Design and construction include all activities necessary for detailed design and erection of the NOXSO demonstration plant, including a process hazard evaluation/safety review and a system shakedown test. Detailed design includes final preparation of all engineering drawings and equipment specifications necessary to procure all materials of construction. The process hazard evaluation/safety review will include the following: design system review, electrical classification review, safety department audit, and a "what if" procedure. Shakedown activities include inspections, tests, and calibrations that are required to ensure that all components are properly installed, prepared, and fully functional at start-up.

A plant start-up plan to ensure that the start-up is organized and operational status is achieved in the minimum time and with maximum safety will also be prepared. This plan will identify and determine the sequence of steps for facility start-up and will present the essential information and procedures required by operation personnel for normal start-up, continuous operation, shutdown, and emergency procedures. Design and construction will be completed in approximately 17 months.

A two-year test and demonstration of the NOXSO Process will be followed by commercial operation. During the two-year test and demonstration period, three test programs will be

Figure 2-11. Project Milestone Scheduling Chart



completed. The first, a parametric test program, will evaluate the effect of major process variables such as sorbent circulation rate, adsorber bed depth, regenerator residence time, and regenerator temperature on system performance. The second, a transient test program, will evaluate the performance of the NOXSO Process during start-up, shutdown, and upset conditions. The transient test program will demonstrate process stability, sensitivity of the process to upsets, ability of the process to recover after an upset, and the effectiveness of the process logic control. The third and final test program, a long duration test, will demonstrate the NOXSO system availability and provide data for operating and maintenance costs at steady-state operating conditions. The completion of the test program will provide process-operating data which will be used to confirm the process economics and provide a basis to guarantee commercial-scale process performance. The NDP will be operated commercially by NOXSO for eight years after the conclusion of the two-year demonstration. After the 10 year demonstration and commercial operation of the NDP by NOXSO, Alcoa will commercially operate the NOXSO Process for an indefinite period of time.

2.2.3 Project Source Terms

Those components of the project which may be determined to have an impact on the environment are referred to as project source terms. The project source terms for the NOXSO Process and SRU include air emissions, aqueous wastewaters, solid waste and noise, and are addressed as they relate to both the construction and operation phases of the NOXSO Process and SRU. Impacts associated with these environmental considerations are discussed in Section 4.0.

2.2.4 Potential Environmental, Health, Safety and Socioeconomic Receptors

A number of environmental features could potentially be affected by the proposed action. These include air quality, ground water quality, land use, labor force, and energy resources. Section 3.0 focuses on characterizing the existing environment with respect to these probable receptors. Section 4.0 evaluates the probable impact of the proposed project on these receptors.

2.2.5 Project Resource Requirements

The NOXSO Process and SRU energy and material resource requirements are discussed in the following sub-sections and summarized in Table 2-8.

2.2.5.1 Coal

As described in Section 2.12, all four units at the WPP currently are fired with coals blended not to exceed the SIP limit of 5.11 lb SO₂/mm Btu of heat input. The blend consists of roughly 80% Squaw Creek coal (at 5.8 lb SO₂/mm Btu) and 20% low-sulfur Appalachian coal. Unit 2 commencing with the start-up of the NDP will be fired exclusively by high-sulfur Squaw Creek coal. Assuming a power plant operating capacity of 90%, Unit 2 would require roughly an additional 102,000 tpy of Squaw Creek coal while the consumption of low-sulfur coal would be reduced by approximately 93,000 tpy. The switch to firing only Squaw Creek coal in Unit 2 is enabled due to the installation of the NDP; however, it is not a requirement of the NDP.

Table 2-8 NOXSO Plant Demonstration Resource Requirements

RESOURCE	UNITS	NDP
Coal	tpy	0
Fuel Oil	gpy	0
Natural Gas	scfh	116,000
Water	mgd	0.21
Power		
Electrical Energy	MWhr/yr	21,413
Steam*	lb/hr	15,000
Labor		
Construction	#Persons	160
Operating	#Persons	15
Land	Acres	<1
Miscellaneous		
Sorbent	tpy	639
Steel (Construction)	tons	387
Concrete (Construction)	cy	5,154
* SRU will provide this steam		

2.2.5.2 Fuel Oil

No additional fuel oil will be required for operation of the NOXSO Process and SRU.

2.2.5.3 Natural Gas

The natural gas requirements are approximately 116,000 scf/hr with a high heating value (HHV) of 1000 Btu/ft³. At 100% load, the maximum gas requirement would be 0.91 billion standard cubic feet (BSCF) per year for the duration of the of the project.

2.2.5.4 Water

The NOXSO Process and SRU use approximately 0.21 mgd for various process operations. No additional sanitary water usage is anticipated. This water is expected to be provided by the six on-site deep-water wells.

2.2.5.5 Power

Electrical

The net electrical consumption is approximately 2,800 KW.

Steam

The steam required for NOXSO sorbent regeneration, NOXSO sorbent transport, and SRU operation will be supplied by waste heat recovery within the SRU. Due to the start-up sequence of the NDP, it is anticipated that startup steam will also be provided by the SRU. Alternatively, start-up steam and/or some operational requirements may be obtained from the Unit 2 boiler if required. It is estimated a total of 15,000 lb/hr of steam will be required for start-up and typical operation.

2.2.5.6 Labor

An estimated 160 construction, supervision, and labor personnel will be required during construction.

Operation of the NOXSO Process and SRU will require approximately three engineering and operations personnel per shift. Two employees will be required for the operation and maintenance of the NDP while one employee will be required for test program activities.

2.2.5.7 Land

The NOXSO Process and SRU will occupy about an acre of unutilized land within the Alcoa facility.

2.2.5.8 Miscellaneous Resources

Sorbent

The NOXSO sorbent used in the NOXSO Process is sodium carbonate deposited on a gamma-alumina substrate. The exact composition and process for manufacturing the sorbent are patented by the NOXSO Corporation and licensed to the W.R. Grace & Co.-Conn. for manufacturing. NOXSO Corporation fully intends to test and license alternative suppliers of NOXSO sorbent prior to the start-up of the NDP.

The NOXSO sorbent attrition rate is approximately 167 pph. Based on the average anticipated capacity factor of 90% and NDP availability of 97%, approximately 639 tons per year (tpy) of NOXSO sorbent will be used.

Steel

Construction of the NOXSO Process and SRU will require 387 tons of structural steel.

Concrete

Construction of the NOXSO Process and SRU will require 5,154 cy of concrete.

2.3 Alternatives

2.3.1 Alternatives Eliminated from Consideration

Under Round III of the CCT Demonstration Program, DOE solicited proposals to conduct cost-shared CCT projects to demonstrate innovative, energy efficient, technologies that offered the prospect for commercialization in the 1990's. The selection guidelines included the capability of reducing emissions from existing facilities and/or providing for future energy needs in an environmentally acceptable manner. Other than compliance with these basic objectives of the CCT Demonstration Program, location of the project in the United States, and the use of coal from U.S. mines, the prospective offerors were not constrained with regard to technology or site. For those proposals submitted that were determined to be suitable for comprehensive evaluation, each received a confidential pre-selection environmental review. This review summarized for the Source Selection Official the strengths and weaknesses of the specific project relative to the environmental evaluation criteria including, to the maximum extent possible based upon the information provided in the proposal, a discussion of alternative sites and technologies reasonably available to the proposer, a brief discussion of the potential environmental impacts of each proposal, necessary mitigative measures, and to the extent known, a list of permits and licenses which must be obtained in implementing the proposal.

Based upon the overall technical and environmental merit of the respective proposals, including the Program Policy Factors, the Source Selection Official selected a series of projects for possible cost-shared financial assistance, within the budgetary constraints of Round III of the CCT Demonstration Program. The proposed demonstration project was included among the twenty three-selected under Round III of the CCT Demonstration Program for its potential to demonstrate the use of innovative emission-reducing technologies for the control of SO₂ emissions from coal-fired boilers. Given the nature of the CCT selection process, DOE is limited to either accepting or rejecting the overall demonstration project as proposed by the participant, including both the technology and site designated by the offeror. Therefore, the only technology and sites addressed in this EA are those proposed by the participant. Alternative sites were considered by the offeror, and these sites are discussed later in this section.

2.3.2 No-Action Alternative

Under the No-Action Alternative, whereby DOE does not provide cost-shared funding support, it is likely that the NOXSO advanced flue gas cleanup technology would not be demonstrated. Consequently, the current WPP Unit 2 SO₂ and NO_x annual emissions would not be reduced

by an anticipated 94% and 73%. NOXSO may elect to complete the project without DOE participation or cancel the project which would result in the project not contributing to the objective of the CCT Demonstration Program, which is to make a number of advanced, more efficient, economically feasible, and environmentally acceptable flue gas cleanup technologies available to the U.S. energy marketplace. Without DOE funding, the offeror would likely not construct the proposed demonstration project. If the NOXSO Process is not demonstrated, it is unlikely that electric utilities would be able to plan the use of this advanced flue gas cleanup technology as a component of their strategy to attain post-2000 air quality standards for SO₂ and NO_x.

2.3.3 Alternative Sites

The goal of the NDP is to achieve commercial application of the NOXSO Process. To this end, the NOXSO Corporation has successfully completed five of six necessary steps. To demonstrate the full potential of the NOXSO Process, the sixth step, the Demonstration Project, requires an operating coal-fired utility. Step five, a 5-MWe pilot plant POC, was completed in August 1993 after successfully operating over 6500 hours on flue gas.

The original host site for the NDP as awarded in CCT-III was Ohio Edison Niles Station, Unit 1. However, due to an inability to negotiate an acceptable disposition for the NOXSO facility after the demonstration period, the Ohio Edison Niles Station was dropped as the host site. A total of four facilities were considered as new host sites:

Alcoa Generating Company, Warrick Power Plant Unit 2
Cincinnati Gas and Electric, Miami Fort Unit 6
Richmond Power & Light, WUVS Unit 1
Penelec, Seward Unit 15.

2.3.3.1 Site Selection Criteria

The power plants identified above were evaluated for suitability as the Host Plant Site for the NDP based on the following criteria:

- An existing power plant that used high sulfur coal.
- A facility with the capacity to provide an adequate flue-gas stream for the NDP.
- A host power producer with experience with projects of this type.
- A facility located in an area where the local government agencies see the benefits of and support projects of this type.
- Sufficient plant site space for the retrofit installation.
- Having an established operating and maintenance program.

- Localized demand for the by-products (i.e., sulfur or liquid SO₂).
- Availability of resources necessary for construction and operation including labor and raw materials.
- The potential for long term commercial operation of the NOXSO Process after the completion of the demonstration phase.

2.3.3.2 Comparison of Alternative Sites

WPP was chosen for the host site for the following reasons:

- WPP, as well as the other three, burns high sulfur coal.
- WPP has an abundance of space available for the retrofit project.
- Power plants of any size can be retrofitted with the NOXSO technology by either scaling the module size up or down, or using multiple modules. The capacity of WPP (144-MWe gross) is in the range of the proposed NOXSO module size of 100-150-MWe.
- WPP is situated in a region with an under-utilized skilled and unskilled labor market that should be available for project construction and operations.
- The NOXSO Process will be operated commercially after the completion of the demonstration phase of the NDP.

2.4 References

1. Indiana Code (IC) 13-2-6.1
2. Indiana Department of Natural Resources, Division of Water, Robert Harris, 1993 print out of surface water attributes in project area.
3. Indiana Department of Natural Resources, Division of Water, Robert Harris, 1993 print of ground water attributes in project area.
4. Indiana Department of Natural Resources, Division of Water NPDES Application. Application No. IN0001155.

3 EXISTING ENVIRONMENT

This section describes the existing environment within and around the WPP. The CCT Demonstration Project will be installed within this power plant. A detailed description of the project site location, the atmospheric, land, and water resources, the ecological conditions, and the socioeconomic, aesthetic, and cultural resources is provided.

3.1 Atmospheric Resources

3.1.1 Site Meteorology

The Evansville, Indiana, area has a temperate continental climate, which is influenced by the action of alternating polar and tropical air masses. Annual temperature and precipitation data for the Evansville area are presented in Table 3-1 (Ref. 1).

Table 3-1 Average Evansville, Indiana, Temperature and Precipitation Data

Month	Average Daily Temperature (°F)			Average Precipitation (water equivalent) (inches)
	Max	Min	Mean	
January	41.4	25.0	33.0	3.53
February	44.1	27.1	35.6	3.19
March	55.1	36.4	45.8	4.30
April	66.3	46.0	56.2	3.94
May	76.3	55.6	66.0	4.19
June	85.4	64.7	75.1	3.84
July	88.8	68.6	78.7	3.52
August	87.2	66.7	76.9	3.18
September	81.3	59.5	70.4	3.11
October	70.0	47.5	58.8	2.78
November	55.4	37.1	46.3	3.55
December	43.8	28.3	36.0	3.43
Year	66.3	46.9	56.6	42.54
Source: Reference 1.				

The average monthly temperature ranges from 33°F (January) to 78.7°F (July), with a mean annual temperature of 56.6°F. The mean annual precipitation is 42.54 in., which includes an average snowfall of 13.8 in. These data represent 30-year averages from 1961 to 1990. Clear days (30% cloud cover or less) occur an average of 35% of the year, while cloudy days (80% or more cloud cover) occur an average of 22% of the year (Ref. 2). The proposed site is located far enough from the Great Lakes region that it is not influenced by the unique meteorological conditions associated with that region, such as a land/lake interface.

Figure 3-1 presents a wind rose for the WPP area for 1993. Meteorological data used to generate the wind rose are surface data recorded at Indiana air quality monitoring site 18-173-0002. The monitoring site is about 2 miles north-northeast of WPP and is representative of the meteorological conditions at the WPP site.

3.1.2 Air Quality

The Indiana Department of Environmental Management (IDEM) tracks air quality by county. The Warrick Operations and the WPP are in a region (Warrick County) that attains National Ambient Air Quality Standards (NAAQS) for NO_x, carbon monoxide (CO), ozone, PM, and SO₂. An attainment designation has not been made for lead (Pb). The neighboring county to the west, Vanderburg County, Indiana, is nonattainment for ozone and also does not have an attainment designation for Pb. Across the Ohio River, Henderson County, Kentucky, is in attainment for SO₂, NO_x, PM₁₀, and O₃. An attainment designation has not been made for Pb. NAAQS designations for Warrick County and four surrounding counties are shown in Table 3-2.

Summaries of maximum concentrations of NAAQS pollutants are shown in Table 3-3.

The criteria pollutants Pb, CO, and NO₂ are currently not monitored within Warrick County. For these criteria pollutants, maximum concentrations from adjacent counties have been included. The closest Class I area, as defined under the federal and state Prevention of Significant Deterioration (PSD) program, is Mammoth Cave, which is located outside the PSD 100-kilometer range (Ref. 3).

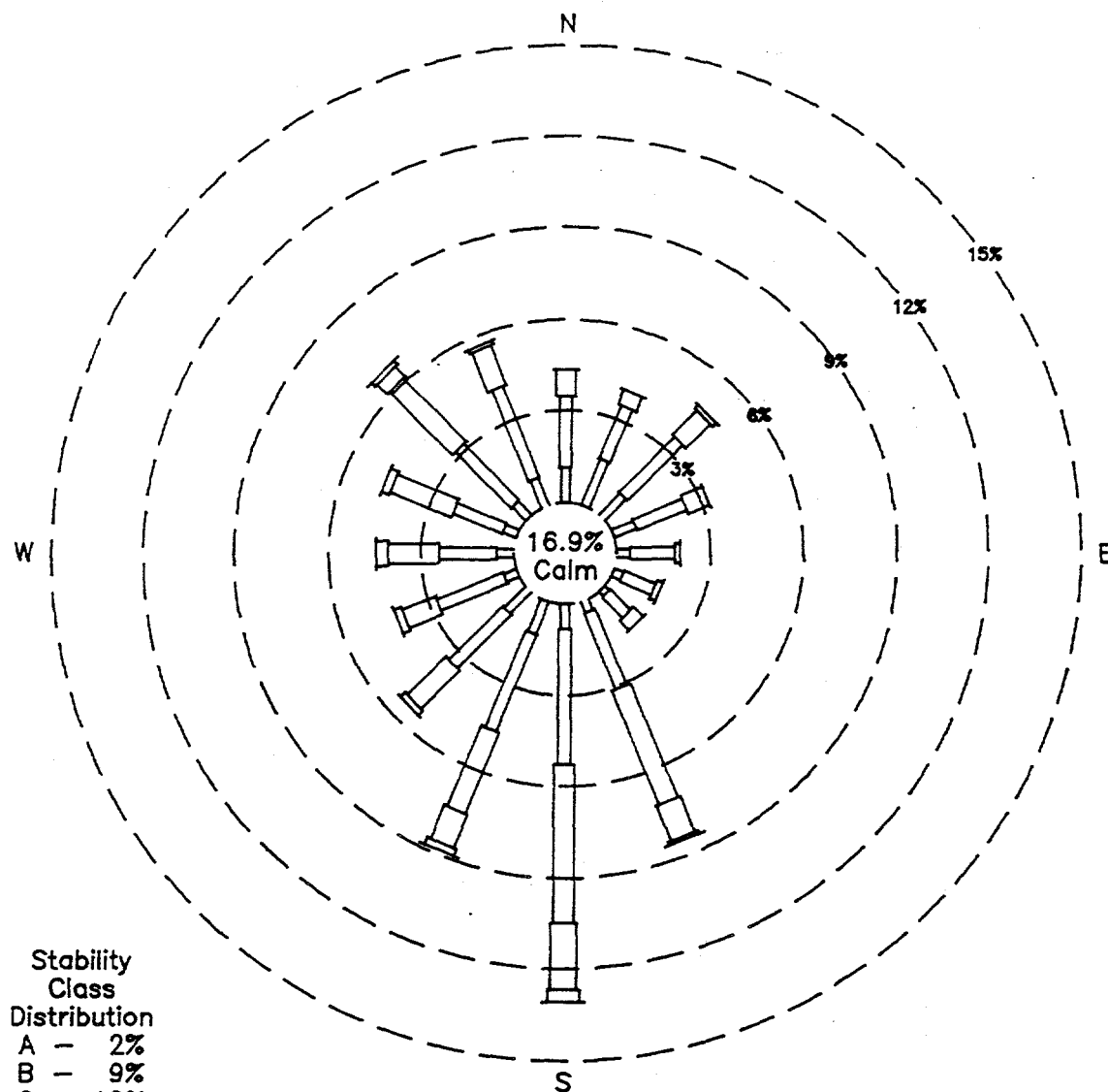
WPP and Warrick Operations operate three ambient air quality monitoring stations in Indiana, stations 18-173-0002, 18-173-0003, and 18-173-1001. As required by the IDEM, all three stations provide SO₂ ambient air monitoring. Two stations have meteorological data collection towers while one station provides ozone and PM monitoring.

3.2 Land Resources

3.2.1 Topography

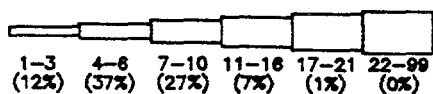
Warrick Operations and the WPP are located on the higher, northern bank on the Indiana side of the Ohio River (see Figure 2-3). The alluvial plain is to the south on the Kentucky bank. The area where the facility is located has been filled with local soils to a height 30 to 40 ft above the natural soil level. Unaltered terrain in this region slopes less than 1 degree (about

Frequency of Wind Direction and Speed



Stability
Class
Distribution

A	-	2%
B	-	9%
C	-	12%
D	-	43%
E	-	10%
F	-	23%



Wind Speed Scale (Knots)

Note - Wind Direction is the
Direction Wind is Blowing From

Figure 3-1. Evansville, Indiana, 1985 Wind Rose

AC-0330

Table 3-2 NAAQS Attainment Designations

Pollutant	Warrick County Indiana	Vanderburgh County Indiana	Spenser County Indiana	Henderson County Kentucky	Daviess County Kentucky
SO ₂	unclassifiable	attainment	attainment	attainment	attainment
NO ₂	unclassifiable/attainment	unclassifiable/attainment	attainment	attainment	attainment
PM ₁₀	unclassifiable	unclassifiable	attainment	unclassifiable	unclassifiable
CO	unclassifiable/attainment	unclassifiable/attainment	unclassifiable/attainment	unclassifiable/attainment	unclassifiable/attainment
O ₃	unclassifiable/attainment	Evansville area - nonattainment: marginal	unclassifiable/attainment	unclassifiable/attainment	nonattainment: marginal
Pb	not designated	not designated	not designated	not designated	not designated
TSP	not designated	City of Evansville and Pidgeon Township-nonattainment (does not meet secondary standards), rest of County - attainment	attainment	Henderson (city) - unclassifiable, rest of County - attainment	Owensboro (city) - unclassifiable, rest of County - attainment

Source: 40 CFR 81 (confirmed with Indiana Department of Environmental Management and Kentucky Environmental Protection Agency)

Notes:

1. Designation definitions (from Clean Air Act Section 107(d)(1)(A)(i-iii).

nonattainment - Any area that does not meet (or that contributes to ambient air quality in a nearby area that does not meet) the national primary or secondary ambient air quality standard for the pollutant.

attainment - Any area (other than an area identified as nonattainment) that meets the national primary or secondary ambient air quality standard for the pollutant.

unclassifiable - Any area that cannot be classified on the basis of available information as meeting or not meeting the national primary or secondary ambient air quality standard for the pollutant.

2. Ozone nonattainment designations are categorized by severity: marginal, moderate, serious, severe, or extreme.

3. Unclassifiable/attainment means the area is either unclassified or has attainment status. Unclassifiable areas are generally presumed to have acceptable air quality. Areas which are not designated for lead have no major lead emission sources. Warrick County is not included in EPA regulations for TSP and is therefore listed as not designated.

Table 3-3 Regional Air Quality Monitoring Data

Pollutant (unit)	Averaging Time	NAAQS		Indiana AAQS		Monitoring Station County (year)	Monitoring Station Data	
		Primary Standards	Secondary Standards	Primary Standards	Secondary Standards		Averaging Time	Concentration ² Concentration ²
SO ₂ (μg/m ³)	annual ¹ 24-hr 3-hr	80 365 4	4 4 1300	80 365 4	4 4 1300	18-173-0002 Warrick (93) 18-173-0003 Warrick (93) 18-173-1001 Warrick (93)	annual 24-hr 3-hr annual 24-hr 3-hr annual 24-hr 3-hr	40 192 694 34 146 626 37 182 790
NO ₂ (μg/m ³)	annual	100	100	100	100	18-163-0012 Vanderburgh (93) 18-147-0006 Spencer (94)	annual annual	20 ⁵ 20 ⁵
PM ₁₀ (μg/m ³)	annual 24-hr	50 150	50 150	50 150	50 150	18-173-0002 Warrick (93) 18-173-0010 Warrick (93)	annual 24-hr annual 24-hr	31 87 20 ⁵ 32
CO (mg/m ³)	8-hr 1-hr	10 40	4 4	10 40	10 40	18-163-0015 Vanderburgh (94)	8-hr 1-hr	7 9
O ₃ (μg/m ³)	1-hr	235	235	235	235	18-173-0008 Warrick (94) 18-173-0009 Warrick (94)	1-hr 1-hr	238 228
Pb (μg/m ³)	3-mo.	1.5	1.5	1.5	1.5	Not monitored		

Notes:

1. Most recent data presented.
2. Maximum concentration for the indicated averaging time.
3. Annual arithmetic mean.
4. No standard exists
5. Mean does not satisfy summary criteria, per EPA report notes (i.e., insufficient number of data points to qualify as calculated mean for NAAQS reporting).
6. Warrick County monitoring stations 18-173-0002, 18-173-0003, and 18-173-1001 are operated by Alcoa.

Source: Indiana Department of Environmental Management Office of Air Management and EPA Aerometric Information Retrieval System (AIRS).

30 ft per mile) down to the river bank, which drops steeply to the river. The area surrounding the WPP consists of flat and rolling terrain interspersed with hilly areas disturbed by strip-mining for coal (Ref. 4).

On a regional scale, the site is situated on a limb of the Cincinnati Arch, which is characterized by relatively rugged topography. Surrounding the limb is an area of flat land to rolling hills (Ref. 5).

3.2.2 Geology

The geology in the area of the WPP consists of recent alluvial silt, sand, and gravel over shale, sandstone, limestone, clay, and coal of the Pennsylvania Age Carbondale Group. Much of the area is covered with a layer of glacial outwash and loess accompanied by alluvial and lacustrine sand, silt, and gravel. These Quaternary-age sediments have measured thicknesses of 130 ft or more, based on well logs from water wells at Warrick Operations (Ref. 6). Underlying the Quaternary sediments is Pennsylvanian bedrock. Reflecting deltaic deposition, the bedrock is typically shale, but the shale can be interbedded with layers of sandstone, limestone, and coal. Earth resources in the area are coal, which is strip-mined, and oil. Bedrock aquifers tend to be in the discontinuous sandstone units (Ref. 7).

Soils at the WPP are 60% Huntington series by area, 15% Woodmere series, and 25% Wheeling series (Ref. 8). The Huntington silt loam is a well-drained, moderately permeable, neutral soil. The Woodmere silty clay loam is a deep, well-drained neutral soil with moderately low permeability. Both Huntington and Woodmere soils are typically found on floodplains. The Wheeling series soils are neutral-to-highly-acid silt loams subdivided by their slopes, which are either 0-2% slopes for Wheeling A, and 2-6% slopes for Wheeling B2.

The four ash ponds at the site have been excavated from an area of floodplain soils. These soils include the Huntington, Woodmere, and Wheeling soils discussed above, plus Newark and Weinbach soils (Ref. 9). Newark silty clay loams can have strongly acidic subsoils with moderate permeability. Weinbach silt loams are also strongly acidic and have very low permeability. Both soils are found in swells within floodplains (Ref. 9). At this site, the Newark and Weinbach soils are interspersed between the Wheeling soils, which are old river beach terrace deposits. Much of this area is now affected by ash pond construction. Wastewater streams from both the WPP and Warrick Operations flow into these ash ponds.

The WPP is located in the seismic Zone 2A, as designated by the 1989 Indiana Amendments of the Uniform Building Codes (UBC) (Ref. 10). The zones in the UBC provide guidance on building design. The zone numbers are used in a series of equations used to quantify that guidance. Zone 1 requires the least stringent building design and higher zone numbers require more stringent building design. The UBC Zone 2A corresponds closely with the Mercalli risk scale Zone 2.

The most severe earthquakes recorded in the area were in New Madrid, Missouri, located approximately 150 miles from the Alcoa facility, and took place over several months in the years

1811 and 1812 (Ref. 11). Earthquake shocks are still sometimes experienced in the area, although they are relatively small in comparison to the New Madrid earthquake (Ref. 12).

3.2.3 Prime and Unique Farmland

The Farmland and Policy Protection Act (FPPA) serves to identify farmlands which are classified as prime, unique, or of state or local importance. The FPPA does not directly protect the farmlands from a regulatory stand point. According to a map provided by the Soil Conservation Service Division of the USDA, prime farmlands surround the existing facility. However, the map is dated 1983 and is compiled from maps and photographs dating back to 1960. (Ref. 13)

3.3 Water Resources

3.3.1 Surface Water

Figure 3-2 shows the locations of surface water features and water users in the vicinity. The Ohio River and its tributaries (particularly Little Pigeon Creek and Cypress Creek) constitute the major surface water features in the site area. There are three cities located in the vicinity of the project site: Evansville, located about 15 miles to the northwest; Newburgh, located 2.5 miles to the northwest; and Yankeetown, located about 1 mile to the east.

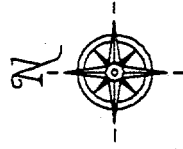
3.3.1.1 Water Usage

Industrial and municipal users of surface water along the Ohio River in Warrick County include: 1) the Cully Station, immediately to the east of Warrick Operations; 2) Warrick Operations and the WPP; and 3) the municipality of Evansville. The Cully Station has three intake pumps on the river with a combined withdrawal capacity of 365 mgd. In 1993, the Cully Station diverted an average of 82 mgd from the river. The WPP have eight intake pumps with a combined capacity of 616 mgd. In 1993, these pumps diverted an average of 444 mgd from the river. Warrick Operations and the WPP use surface water primarily for cooling and ash-sluicing at their facilities. Evansville diverts water from six intake pumps located on the Ohio River for its municipal water supply system. In 1993, these pumps diverted an average of 27.4 mgd from the river. Newburgh's primary drinking water source is groundwater. There are no high-capacity (greater than 0.1 mgd) industrial users of surface water located in Newburgh. (Ref. 14) Water usage for the WPP is detailed in Section 2.1.4.3.

There are currently no specific regulations regarding surface water use during low-flow conditions (Ref. 13). The state is working to develop low-flow regulations; however, low-flow regulations will not directly impact the project because additional water needed for the NDP will be supplied from existing deep-water wells.

Evansville

LS Ayers & Company



Chandler
Water
Department

Ind. Cities
Water Corp.
Newburgh

Flow

Newburgh Locks
and Dam

Cypress Creek

Warrick
Power Plant

Culley
Plant

Little Pigeon Creek

Yankeetown
Dock Corp.

Yankeetown
Water Corp.

Ohio River

Green
River

OWWB28

OWWB27

Not to Scale

OWWB-Ohio Valley Water Body

Figure 3-2. Water Features Schematic

3.3.1.2 Water Quality

Three agencies are involved with the water quality and quantity of the Ohio River and its tributaries. These agencies are the Ohio River Valley Water Sanitation Commission (ORSANCO), the Indiana Department of Natural Resources (IDNR), and the IDEM.

ORSANCO is responsible for reporting on the Ohio River water quality and conditions, but is not a regulatory agency. The Commission is an interstate agency created to execute a compact among the Ohio Valley States (Pennsylvania, Ohio, West Virginia, Kentucky, Indiana, Illinois, New York, and Virginia) to address water pollution in the Ohio River basin. ORSANCO monitors and assesses the water quality of the Ohio River for the states of Indiana, Illinois, Kentucky, Ohio, Pennsylvania, and West Virginia. (Ref. 15)

The IDNR is responsible for tracking high-capacity water use on the Ohio River and its tributaries. The IDEM is responsible for the water quality of those rivers and streams not tracked by ORSANCO. The IDEM primarily tracks water quality for all waters within the state other than the Ohio River.

As required by Section 305(b) of the Federal Clean Water Act, ORSANCO designates uses of the Ohio River and assesses whether the water quality supports these uses. ORSANCO designates this water quality information by "waterbodies." As shown in Figure 3-2, the waterbodies that are within the influence of wastewater discharges from Warrick Operations and the WPP include Ohio Valley Waterbodies (OVWB) 27 and 28. OVWB27 includes the Ohio River from Cannelton Locks and Dam (Ohio River mile 720.7) downstream to the Newburgh Locks and Dam (mile 776.1). OVWB28 includes the Ohio River from the Newburgh Locks and Dam (mile 776.1) downstream to the Green River (mile 784.2). Warrick Operations and the WPP divert surface water from OVWB27 and discharge wastewater back into that waterbody. (Ref. 15)

ORSANCO's designated water quality uses for OVWB27 include public and industrial water supply, full-body recreational contact, warm water aquatic habitat (aquatic life), and fish consumption. When the water quality of a waterbody is not high enough for its designated uses the use is considered "partially supported" or "not supported." According to ORSANCO, OVWB27 is partially supported for all water quality uses. OVWB28 is partially supported for all water quality uses except for a not supported designation for recreational use. The primary pollutant sources contributing to the partially supporting and not supporting use designations are nonpoint sources (nps), particularly agriculture and urban runoff and combined sewer outfalls (CSO). The major nps pollutants include pesticides, priority organics, and metals. (Ref. 15)

There are two major tributaries that flow into OVWB28: Little Pigeon Creek (located southeast of the Warrick facilities), which enters the Ohio River at mile 773, and Cypress Creek (located northwest of the facilities), which enters at river mile 775.5. Both Little Pigeon Creek and Cypress Creek are located in Warrick County and have designated uses of full-body recreational contact, fish consumption, and aquatic life. There are no high-capacity (greater than 0.1 mgd) water users associated with either Little Pigeon Creek or Cypress Creek. (Ref. 13)

3.3.1.3 Floodplain

The WPP is located on the Ohio River at river mile 774. Flood protection for the WPP is provided by two dams on the Ohio River: the Cannelton Dam, which is 53.3 miles upstream at river mile 720.7, and the Newburgh Dam, which is 2 miles downstream at river mile 776 (Ref. 16). The relationship of the Newburgh dam to the WPP is depicted in Figure 3-2.

Based on the latest available Federal Emergency Management Administration (FEMA) 1982 Flood Hazard Boundary Map, the WPP falls in Zone C, or areas of minimal flooding. The latest computed profile for the Ohio River, published by the Ohio River Division of the U.S. Army Corps of Engineers in 1978 indicates a 100-year frequency flood could be expected to reach an elevation of 383 ft above mean sea level at the WPP. The area of 100-year flood frequency is designated as Zone A-10 on the 1982 FEMA map. Fly ash disposal ponds A, B, C, and D all fall within Zone A-10 (Ref. 17). However, all four fly ash disposal ponds were constructed at elevations higher than this: Pond A was constructed at an elevation of 394 ft, Pond B at 389 ft, Pond C at 389 ft, and Pond D at 395 ft (Ref. 18). A 1991 photogrammetric survey performed by Morley and Associates, Inc., an Evansville, Indiana engineering firm, confirms that all of the dikes around the ash disposal ponds are above the 100-year frequency flood level of 383 ft elevation (Ref. 18).

Additionally, all fly ash ponds were approved by the Indiana Natural Resource Commission, Docket No. G-4744, Part I, II, and III. The height of the ponds is above the floodplain and, therefore, no restrictions were noted. The site of these four ponds is approximately 1.4 miles upstream from Newburgh Locks.

3.3.1.4 Wetlands

Numerous scattered wetlands occur along the Ohio River, Cypress Creek, and Little Pigeon Creek. The wetlands consist primarily of bottomland hardwood and riverbank forests, and freshwater marshes dominated by the wetland plant species *Phragmites gigantea* and *Typha latifolia*. Within a 5-mile radius of the WPP, only two wetland areas are considered high quality natural communities (Ref. 19). Both are upstream of the WPP, one near Yankeetown on the Ohio River, and one on Cypress Creek.

Wetlands on the Warrick Operations and WPP property were assessed by the Army Corps of Engineers in 1980. At that time, a Section 404 permit was issued to allow the construction of Ash Pit D in a jurisdictional wetland. In conjunction with issuance of the permit, a mitigation agreement was also signed in which the Corps confirmed that no wetlands, other than those permitted, exist on the Warrick Operations and the WPP property. The agreement further states that "any future use by Alcoa of any real property at the facilities shall not require a permit application as a wetland pursuant to Section 404 or the 404 Regulations" (Ref. 20).

3.3.2 Groundwater

The principal aquifer in the area is an unconfined aquifer located in the Ohio River Alluvium (Ref. 21). Newburgh's principal public water supply is groundwater. The Indiana Cities Water Corporation of Newburgh has four public wells with a combined capacity of 1.9 mgd. In 1993, these wells yielded 382 million gallons total. These wells produce approximately 1.0 mgd and service more than 87,000 people. The Chandler Water Corporation, located about 1 mile west of Newburgh, has six public wells with a combined capacity of 8.5 mgd. In 1993, these wells yielded 581 million gallons. (Ref. 22)

Yankeetown Water Corporation uses three wells for the Yankeetown public water supply. In 1993, these wells yielded 45 million gallons (an average of 0.1 mgd), and they have a combined capacity of 0.9 mgd. Industrial groundwater users in the Yankeetown area include SIGECO, Yankeetown Dock Corporation (located three-quarters of a mile upstream from the WPP), and Warrick Operations/WPP. SIGECO has four wells with a combined capacity of 2.4 mgd. In 1993, these wells yielded 126 million gallons (an average of 0.4 mgd). The Yankeetown Dock Corporation has one well with a capacity of 250 gpm. In 1993, this well produced 0.1 million gallons. Warrick Operations and the WPP have six deep-water wells with a combined well capacity of 17 mgd. Warrick Operations and the WPP use approximately 5 mgd of potable water obtained from these wells. This groundwater is treated and is used as process water in both the WPP and Warrick Operations. In 1993, the wells yielded 1.7 billion gallons. IDNR ground water reports Evansville has three high-capacity industrial users of groundwater and one well used by the University of Evansville. The Vanderburgh Building Authority has eight wells with a combined capacity of 5 mgd. These wells are primarily used for heating, cooling, and lawn irrigation, and in 1993 they yielded 60 thousand gallons (an average of 164 gpd). Evansville Concrete Co. has one well with a capacity of 0.4 mgd. This well yielded 1.6 million gallons in 1993 (an average of 4,493 gpd). Zimmerman Farms has one well with a capacity of 1.3 mgd. This well yielded 29.5 million gallons in 1993. The University of Evansville has one well, primarily used for heating and cooling, which has a capacity of 0.2 mgd. This well yielded 12.1 million gallons (an average of 33,041 gpd) in 1993. (Ref. 22)

3.4 Ecological Conditions

3.4.1 Aquatic

Aquatic environments in the area of the WPP include the Ohio River, Cypress Creek, and Little Pigeon Creek. The Ohio River is regulated by dams that function primarily during low-water conditions. Water depth varies considerably as a result of large influxes of water from the large drainage area, limiting development of ecologically functional shoreline habitat.

3.4.2 Terrestrial

Common species of wildlife in the southwestern quadrant of Indiana include rabbits, red and gray squirrels, white-tail deer, some red fox (less common), muskrats, beavers, ground hogs, various songbirds, marsh hawks, and red tail hawks. The principal plant communities on and

adjacent to the WPP are bottomland hardwood forest, mixed hardwood forest, *Typha/Phragmites* marsh, and cropland. However, reclaimed strip-mined areas are prevalent. (Ref. 21)

3.4.3 Threatened and Endangered Species

In 1991, for a since canceled project, the DOE contacted two agencies to obtain information on threatened and/or endangered species in the WPP area. The U.S. Fish and Wildlife Service (USFWS) monitors federally-listed plants and animals. The USFWS provided reports of species whose range includes the site. The Indiana Natural Heritage Program (NHP) monitors federally- and state-listed plants and animals and high-quality natural communities. The NHP reported all threatened and/or endangered species documented to occur within five miles of the project site (Refs. 19, 23). For a list of rare, threatened, or endangered species in the area, see Table 3-4 (Ref. 19). The DOE has contacted the USFWS and Indiana NHP concerning the NDP and the information on threatened and/or endangered species in the WPP area will be updated.

3.4.3.1 Aquatic

There are two aquatic species of federal concern in the vicinity of the project site. The Indiana NHP confirms the occurrence of the copperbelly watersnake (*Nerodia erythrogaster neglecta*) within five miles of the project site (Ref. 19). This species is listed as state threatened (ST), and is designated federally as C₂ (under review). The USFWS reports that the project site is in the range of the federally endangered pink mucket pearly mussel (*Lampsilis orbiculata*) (Ref. 23).

Additionally, the Indiana NHP reported six other state-listed wetland plant species, two state-listed wetland vertebrate species, and two high-quality wetland communities, all occurring within five miles of the project site. These species are listed in Table 3-4. The two high-quality communities are the Cypress Creek slough and the Yankeetown floodplain site. At the Cypress Creek slough, the Indiana NHP has recorded the copperbelly watersnake, two state-listed sedges, a state-listed herbaceous plant, and state-listed bald cypress. At the Yankeetown floodplain site, the Indiana NHP has recorded one state-listed herbaceous plant. None of these species is federally-listed, and natural communities are not addressed at the federal level. (Ref. 19)

3.4.3.2 Terrestrial

The Indiana NHP has reported six state-listed upland plants (none is federally listed) within five miles of the project site. See Table 3-4 for a complete listing of these plants (Ref. 18). The USFWS has reported that the project site is within the range of the federally endangered Indiana bat (*Myotis sodalis*). However, no appropriate nesting or roosting habitat (i.e., caves) is located at the WPP (Ref. 23).

Table 3-4 Species of Concern

Species	Status	Source
Wetland Plants		
Bald cypress (<i>Taxodium distichum</i>)	ST	IN NHP
Climbing dogbone (<i>Trachelospermum difforme</i>)	ST	IN NHP
Carolina Spider-lily (<i>Hymenocallis occidentalis</i>)	ST	IN NHP
Louisiana sedge (<i>Carex louisianica</i>)	SR	IN NHP
Eastern bloodleaf (<i>Iresine rhizomatosa</i>)	ST	IN NHP
Wild mudwort (<i>Dicliptera brachiata</i>)	SE	IN NHP
Upland Plants		
Wolf bluegrass (<i>Poa wolfii</i>)	ST	IN NHP
Meadowrue (<i>Thalictrum polygamum</i>)	ST	IN NHP
Pitcher leather-flower (<i>Clematis pitcheri</i>)	SR	IN NHP
Angular-fruited milkvine (<i>Gonolobus gonocarpes</i>)	SR	IN NHP
American mistletoe (<i>Phoradendron serotinum</i>)	WL	IN NHP
Sedge (<i>Carex socialis</i>)	ST	IN NHP
Wetland Vertebrates		
Least bittern (<i>Ixobrychus exilis</i>)	SSC	IN NHP
Swamp rabbit (<i>Sylvilagus aquaticus</i>)	SE	IN NHP
Aquatic Vertebrates		
Copperbelly watersnake (<i>Nerodia erythrogaster neglecta</i>)	ST, C2	IN NHP
Aquatic Invertebrate		
Pink mucket pearly mussel (<i>Lampsilis orbiculata</i>)	LE	USFWS
Terrestrial Mammals		
Indiana bat (<i>Myotis sodalis</i>)	LE	USFWS
SE = State endangered LE = Federally endangered ST = State threatened LT = Federally threatened SR = State rare C2 = under review (federal) SSC = Special rare WL = watch list IN NHP = Indiana Natural Heritage Program USFWS = United States Fish and Wildlife Service		

3.5 Socioeconomic Resources

3.5.1 Socioeconomic Characteristics

The Warrick County population in 1985 was 45,570, an increase of 9.8% over the population recorded during the 1980 census (Ref. 24). The population at the 1990 census was 44,920 (Ref. 25), which is a decline of about 1.5% since 1985. In 1989, the major employment sectors in Warrick county were services, retail, and manufacturing. Between 1988 and 1989, the greatest growth in Warrick employment was in the services sector; the greatest decline was in manufacturing. Nevertheless, manufacturing is the employment sector that brings the most money in salaries to the county (Ref. 25). The Warrick County unemployment rate for 1991 was 4.9%. The median household income in 1988 was \$25,275 (Ref. 25).

3.5.2 Transportation

Access to the plant is via the SIGECO road off of State Route 66. Route 66 runs east-west about a mile north of WPP. Two traffic counts for Route 66 were obtained. The first point, just east of the SIGECO road, indicated a daily traffic volume of 10,700 while a traffic count west of the SIGECO road indicated a traffic volume of 13,490 (Ref. 26). The traffic volumes are 1991 annual average daily traffic adjusted for three or more axles.

WPP currently receives about 500 coal truck deliveries, 150 commercial and package deliveries, 325 rail car deliveries, and 1200 passenger vehicle round trips per week.

3.6 Aesthetic/Cultural Resources

3.6.1 Archaeological/Historical Resources

In 1991, for a since canceled project, the DOE contacted the Indiana Division of Historic Preservation and Archaeology concerning archaeological and historical resources in the vicinity of the WPP (Ref. 27). The 1991 survey indicated the following potentially significant buildings or structures in the vicinity (within 1.5 miles) of the WPP: the Bates House (circa 1852) and the Belle House (circa 1880), which are both notable for their architecture. The River Road Bridge (circa 1900) is over two miles from the site, and is significant for transportation and engineering (Ref. 28). The Bates House is rated as a notable entry and a potential nominee for inclusion on the Indiana Register of Historic Sites and Structures. The Belle House is recognized by the Historic Landmarks Foundation of Indiana as a contributing structure, which is one that would not be considered for a State or National Register, but does contribute to the uniqueness of the county. The River Road Bridge is recommended as a potential nomination to the National Register (Ref. 29). The DOE has contacted the Division of Historic Preservation and Archaeology concerning the NDP and the above information will be updated.

Six and one-half miles to the west of the WPP are Native American mounds in the Angel Mounds State Park. This state historic site marks the location of a Native American town that was inhabited by about 3,000 people from about 1200 to 1400 AD (Ref. 29).

3.6.2 Native American Resources

The federal government does not recognize any Native American tribes in Indiana (Ref. 30). The State of Indiana does not give official designation to Native American tribes (Ref. 21).

3.6.3 Scenic or Visual Resources

Indiana State Road 66 is classified as a scenic route from Newburgh through Yankeetown, along the Ohio River and north to Sulphur (Ref. 31). This road runs 1,200 ft to the north of Warrick Operations, and slightly more than 1 mile north of the WPP (Ref. 4) . The NDP will not be visible from Indiana State Road 66.

There are no state or federal wild and scenic rivers in the vicinity (Ref. 19).

3.6.4 Recreational Resources

The Ohio River is considered a recreational river (Ref. 15). Additionally, within a 15-mile radius of the project site there are four state parks, memorials, or wildlife management areas: Angels Mounds State Memorial near Evansville, John J. Audubon State Park, Ben Hawes State Park, and Sloughs Wildlife Management Area, which are all in Kentucky. Lincoln State Park is about 22 miles to the northeast and Hoosier National Forest is 40 miles to the east (Ref. 28, 32).

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4 CONSEQUENCES OF THE NOXSO DEMONSTRATION PROJECT

This section presents a comprehensive analysis of anticipated impacts of the NOXSO Demonstration Project (NDP) at the Warrick Power Plant (WPP). As shown in the following sections, the NDP is expected to have net positive environmental consequences for the region.

4.1 Air Quality Impacts

Summary

The primary purpose of the project is to reduce sulfur dioxide (SO_2) and nitrogen oxide (NO_x) emissions at WPP; in addition, total suspended particles (TSP), and PM_{10} will also be reduced. Unit 2 base case annual emissions of SO_2 , NO_x , TSP, and PM_{10} will be reduced by approximately 94%, 73%, 88%, and 83%, respectively. Emissions of other criteria pollutants, carbon monoxide (CO), ozone (O_3) and Lead (Pb), are not expected to change. Construction impacts on air quality are expected to be insignificant.

4.1.1 NOXSO Process Construction Impacts

Air emissions from NDP construction activities will primarily result from the operation of diesel and/or other internal combustion-powered construction equipment. The levels and duration of these emissions are not expected to exceed that which is normally generated at a typical construction project of similar size. Fugitive dust will be generated from excavation, general construction activities, and vehicular traffic. Industry standard practices will be employed for dust suppression and control of fugitive emissions, including tarping vehicles, and utilizing water-sprays and chemical suppressants. Emissions from mobile sources will be kept in conformance with applicable standards for the particular piece of equipment or vehicle.

4.1.2 NOXSO Process Operation Impacts

The NOXSO Process at WPP will be designed for a 98% SO_2 and 75% NO_x removal efficiency. The NOXSO Process availability will slightly reduce the annual emission reductions. Flue gas emission reductions for Unit 2 are shown in Table 4-1 and Table 4-2. The basis for these estimates include a 90% Unit 2 capacity factor and a 97% NOXSO Process availability.

SO_2 & NO_x

As shown in Table 4-1, with an availability of 97% the NDP will reduce WPP Unit 2 SO_2 emissions by 94% to 1669 tpy and NO_x emissions by 73% to 1466 tpy.

Particulate Matter (PM)

The NOXSO Process will reduce TSP and PM_{10} annual emissions from Warrick Unit 2 by about 88% and 83%, respectively. PM_{10} is particulate matter 10 microns in diameter or smaller while TSP includes all particles regardless of size. The PM emissions are shown in Table 4-2.

Table 4-1 Unit 2 SO₂ and NO_x Emission Reductions

	Base Case Emissions ⁽¹⁾ (tpy)	Post NOXSO Emissions ⁽²⁾ (tpy)	(%) Reduction
SO ₂	27,320	1,669	94
NO _x	5,381	1,466	73
(1) Based on operating permit limitations or AP-42.			
(2) Combustion of 100% Squaw Creek coal in Unit 2.			

Table 4-2 Unit 2 Particulate Emissions

PM	Emissions (tpy)				% Reduction
	Base Case	Post NOXSO			
	Fly Ash ⁽¹⁾	Fly Ash ⁽¹⁾	Attrited Sorbent	Total	
TSP	295.3	17.4	19.2	36.6	88
PM ₁₀	197.9	16.8	17.6	34.4	83
(1) Estimated using AP-42 factors and coal ash content of 8.23% (100% SC coal)					

The NOXSO Process will affect the total amount of PM emissions through loss of attrited sorbent in the fluidized beds and sorbent transport systems (See Section 2.2.1.1). This sorbent attrition rate has been measured in previous NOXSO test programs, including the 5 MWe pilot plant POC, and is conservatively estimated at about 0.03% of the fluid bed inventories per hour. Based on a design sorbent circulation rate of about 390,000 pounds per hour (pph) and fluid bed residence time of 84 minutes, the total fluid bed inventory will be about 550,000 pounds of sorbent. This translates to a total sorbent attrition rate of approximately 167 pph.

The attrited sorbent leaves the NOXSO Process with the clean flue gas to the stack (Stream 2, Figure 2-9) and the NO_x recycle (Stream 7, Figure 2-9). Stream 2, prior to exiting to the stack, passes through a baghouse with a design removal efficiency of 97% or better. To be conservative it is assumed that attrited sorbent in the NO_x recycle stream is not removed in the boiler or collected by the ESP. This attrited sorbent is entrained in the flue gas treated by the NOXSO Process and ultimately travels to the baghouse downstream of the adsorber. The 167 pph attrition rate, 90% capacity factor, 97% availability, distribution of sorbent in the system,

and given baghouse efficiency translate to an annual total attrited sorbent emission rate of 19.2 tpy (about 5 pph) of which about 17.6 tpy (about 4.6 pph) is PM_{10} .

The adsorber baghouse is expected to remove significant quantities of existing PM_{10} , i.e., fly ash in the flue gas. Baghouses are commonly used to control particulate emissions, including PM_{10} , from coal fired power plants. Unit 2 fly ash TSP annual emissions will be reduced by approximately 278 tpy while fly ash PM_{10} emissions will be reduced by about 181 tpy.

Another added benefit of the NOXSO Process is the reduction in stack opacity caused by particulate matter suspended in the flue gas. Based on the reduced TSP emission rate and the particulate matter's size distribution, the opacity in both stacks one and two will decrease by about 28%.

CO & CO₂

Any CO produced by the combustion of natural gas in the NOXSO Process and SRU will be oxidized to CO₂ as it passes over the extended surface area of the NOXSO sorbent. The NOXSO Process and SRU will increase CO₂ emissions from WPP Unit 2 by about 4%.

Fugitive Dust Emissions

Fugitive dust emissions from the NOXSO Process during operation will consist primarily of a small amount of sorbent dust released during sorbent loading. Sorbent will be delivered about every other week to the site by tank truck. The sorbent will be loaded into the sorbent storage bin by pressurizing the tank truck and pneumatically conveying the sorbent. Prior to its exhaust to the atmosphere the transport air will pass through a filter with a removal efficiency of 100% for particles 10 microns and larger. Therefore, fugitive dust emissions from sorbent loading are expected to be minimal.

Plume Rise

Neglecting duct heat loss, the base case flue gas temperature at the exit of stacks 1 and 2 is 325°F. As shown in Figure 2-4, the flue gas from Unit 2 is split between stacks 1 and 2. The NOXSO Process will return the "clean" flue gas to the common duct at 275°F where it will be split equally between stacks 1 and 2 and combined with the flue gas from Unit 1 or 3. The resulting stack exit temperature will be about 307°F.

A reduction in effluent plume rise, the vertical distance above the stack the plume rises, can affect the dispersion of air-borne pollutants and the location of maximum ground level concentrations. Plume rise is a function of both flue gas momentum and buoyancy. The 17 °F drop in flue gas temperature will reduce plume buoyancy by about 6%. However, the reduction in plume buoyancy will be partially offset by an increased flue gas flow rate from each stack, i.e., greater flue gas momentum. The NOXSO Process will increase the flow rate of flue gas from stacks 1 and 2 by about 23,000 SCFM each, about 4% over base case.

Several methods for estimating the plume rise are available. Using the Holland equation, which is a function of flue gas momentum and buoyancy, it is estimated that, due to the integration of the NOXSO Process on WPP Unit 2, the plume rise above stacks 1 and 2 will decrease by less than 2%. This is less than the accuracy of the estimating method. Based on this analysis the effect of the NOXSO Process on plume rise will be insignificant.

Plume Visibility

The occurrence of a visible water vapor plume from a stack effluent is primarily a function of the moisture content of the effluent and the ambient atmospheric temperature and relative humidity. Alcoa has indicated that a visible flue gas water vapor plume occurs occasionally during the colder months of the year. This is in agreement with general meteorological principles, which indicate that under cold and dry atmospheric conditions, the development of a visible water vapor plume is likely.

The NOXSO Process will increase the water content of the flue gas from stacks one and two from about 9.8 to 12.2% on a molar basis. Complex mathematical models and detailed effluent and atmospheric information can be used to predict the occurrence of a visible plume. However, this approach is costly and beyond the scope of this document. Given the increase in flue gas water vapor content it is reasonable to expect a slight increase in visible water vapor plume formation with the presence of the plume restricted to the winter, late fall, and early spring seasons of the year.

4.1.3 Sulfur Recovery Unit Construction Impacts

Air emissions resulting from construction of the SRU are considered the same as those presented in Section 4.1.1.1 regarding the NOXSO Process.

4.1.4 Sulfur Recovery Unit Operation Impacts

The SRU will not have any direct air emissions. The tail gas from the SRU, which will contain a small amount of SO₂ that was not converted to elemental sulfur, will be recycled back to the NOXSO adsorbers where the SO₂ can be readsorbed. This recycle stream is included in the material balance calculations used to determine the NDP SO₂ emission reductions.

Fugitive emissions from pumps and valves within the SRU are expected to be minimal. All valves purchased for the SRU will have a maximum leak rate of 125 ppm at 2000psi; the EPA guideline is 500 ppm. Because the SRU operates at a much lower pressure, 5 to 10 psig, the leak rate from the valves will be much less than the maximum specified value of 125 ppm.

4.2 Land-Use Impacts

Summary

As shown in Figure 4-1, the NOXSO Process and SRU unit operations equipment will be installed at WPP immediately south of WPP Unit 2 in an area about an acre in size. The site lies totally within the current plant boundaries, thus, no additional acreage will be required. No toxic or hazardous waste materials are expected to be encountered during construction. Underground utilities are present and will be rerouted and a temporary storage building will require demolition.

4.2.1 NDP Construction Impacts

The following discussion presents potential land-use impacts for the NOXSO Process and SRU.

A geotechnical survey involving standard penetration tests will be conducted to determine soil characteristics for design engineering. Construction activity will begin with clearing and grubbing. Based on foundation design and results from the geotechnical survey, excavation and replacement of current material with new backfill may be necessary. After grading and compaction, foundation work will begin. Driven pilings may be required for deep supports. Medium to shallow foundations will be supported by spread footings.

Soil loss will be controlled during construction by berming, silt fencing, netting, wetting, and other general construction practices which are typically used to prevent erosional loss. The general elevation of the area will be maintained above the predicted 100-year flood frequency elevation of 383 feet. (See Section 3.3.1.3)

Additions to the WPP infrastructure for NDP will include construction of a rail spur, about 1500 feet in length, to the liquid elemental sulfur loadout facility. Plant water, electrical power and natural gas supply capacities are adequate to meet the needs of the NDP. However, a supply network will have to be constructed to extend these supplies to the NDP site. No previously undisturbed land will be utilized by the project. Construction will occur within the Alcoa site and all land has been previously disturbed and filled with local soils to a height 30 to 40 ft above the natural soil level. Therefore, there will be no impact on prime or unique farmland (Section 3.2.3).

4.2.2 NDP Operation Impacts

The following subsections detail the impacts on primary resource requirements for WPP based on the NDP resource requirements discussed in Section 2.2.5. Table 4-3 summarizes the quantities and relative changes in resource requirements for WPP Unit 2 and the NDP.

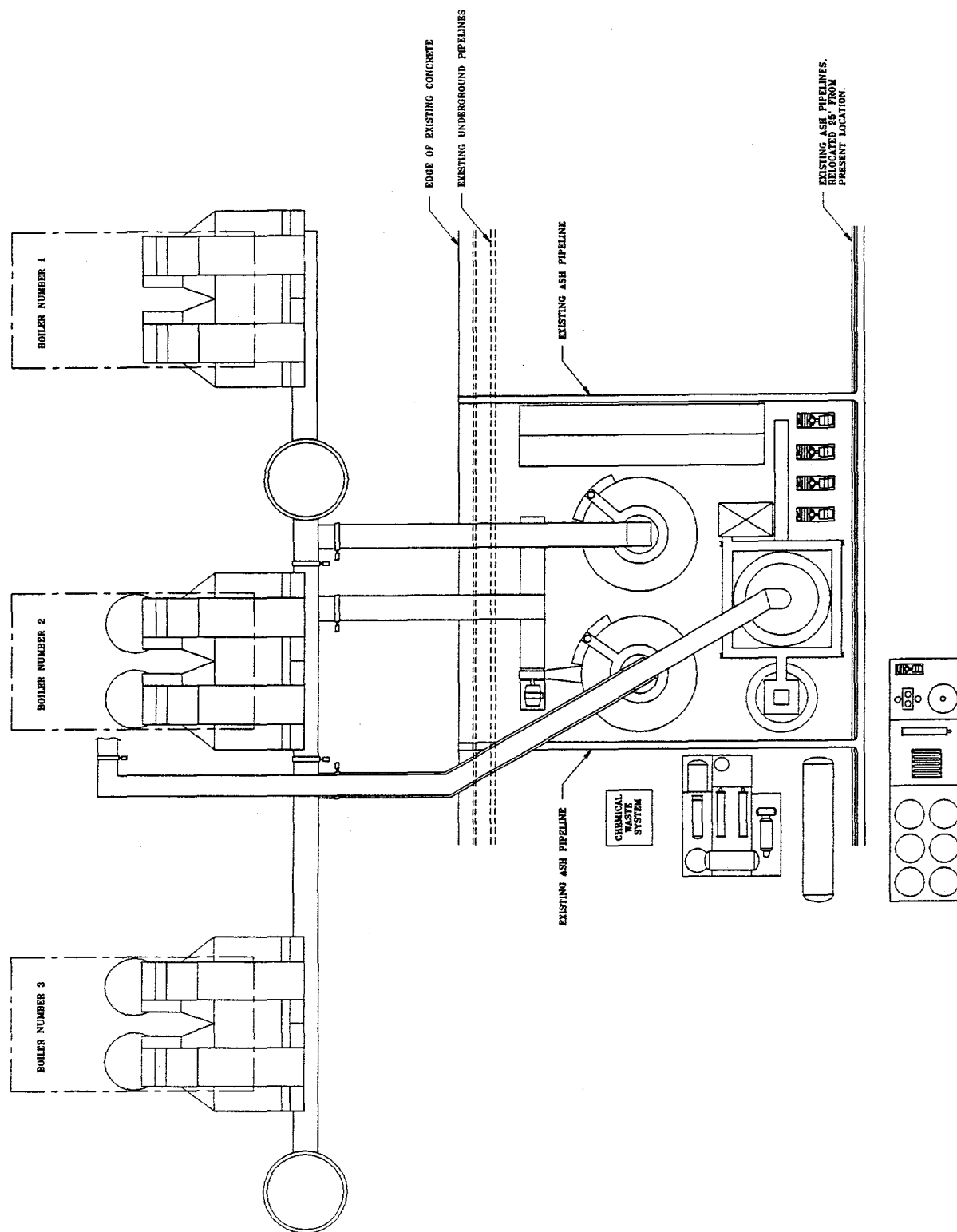


Figure 4-1 NOXSO Demonstration Project Site Location
Alcoa Generating Co. Warrick Power Station

Table 4-3 NDP Unit 1 Resource Requirement Impact Summary

Resource	Unit 2 Requirement ⁽¹⁾	Requirement with NDP ⁽²⁾	Actual Change	% Change
Coal (tpy)	527,649	0	0	0
Fuel Oil (gpy)	46,612	0	0	0
Natural Gas (scfh)	0	116,000	116,000	NA
Water				
Surface (mgd)	93.6	93.6	0	0
Ground (mgd)	0.18	0.39	0.21	216
Electrical Energy (MWhr/yr)	73,352	94,994	21,642	30 ⁽³⁾
Steam (lbs/hr)	Unknown	Unknown	15,000	NA
Labor (#)	180 ⁽⁴⁾	192	12	7
Land (Acres)	~ 600 ⁽⁵⁾	~ 600	~ 1	< 1
Miscellaneous				
Sorbent (tpy)	NA	639	639	NA
Steel (tons)	NA	387	387	NA
Concrete (cy)	NA	5,154	5,154	NA
(1) 1993 consumption with capacity factor of 93.55%. (2) Based on Unit 2 capacity factor of 90% and NOXSO Process availability of 97%. (3) WPP Unit 2 generation is derated by 2.0%. (4) Labor required for all four units at WPP. (5) Includes Warrick Operations and WPP.				

Coal

The NOXSO Process does not decrease coal burning efficiency nor does it require additional coal for its operation. However, during the operation of the NOXSO Process, Unit 2 will be fired exclusively by 5.8 lb SO₂/mm Btu Squaw Creek coal rather than the current coal blend. The switch of coal feed to WPP Unit 2 is an AGC decision and is not a requirement of the NOXSO Process. WPP will consume approximately 102,500 tpy more of Squaw Creek coal and will consume about 93,000 tpy less of low sulfur coal. An expansion of coal storage and handling facilities is not required. The NDP will have no affect on Alcoa's coal supply strategy concerning the Squaw Creek mine (Section 2.1.4.1).

Fuel Oil

The NOXSO Process and SRU do not require fuel oil for operation. Therefore, WPP fuel oil storage and handling facilities are not impacted.

Natural Gas

Operation of the NDP will require approximately 116,000 scfh of natural gas. Based on a 1988 U.S. Department of Energy (DOE) study entitled "An Assessment of the Natural Gas Resource Base of the United States", the US has a 35-year supply of natural gas at prices under \$3.00 per thousand cubic feet assuming current consumption rates. There is a 1,059 trillion cubic feet (Tcf) base of recoverable gas in the lower 48 states with 18 Tcf consumed in 1988. If Alaska and unconventional resource bases are included, the gas resource increases to 50 years. Natural gas is readily available on-site in sufficient quantity to provide for the incremental gas requirements of the project.

Water

The NDP will use approximately 0.21 mgd of water. The water is expected to be provided by the six on-site deep-water wells which have a 17 mgd capacity. Warrick operations and WPP currently use approximately 6 mgd of potable water from these wells.

Power

Electrical

It is currently estimated that the NOXSO Process and SRU's net electrical requirement will be about 2,800 KW. The projects power needs will be supplied internally by WPP, which has ample generating capacity (732 MW) to offset the projects power requirements.

Steam

NDP steam requirements will be met internally through use of steam generated by the SRU. It is estimated 15,000 lb/hr of steam will be required for operation of the NOXSO Process and SRU. Alternately, or in addition, steam may be supplied by the Unit 2 boiler. Use of small quantities of such steam will have minimal impact on Unit 2 generating capabilities.

Labor

Construction of the NDP will require an estimated 160 supervision and construction labor personnel. Operation will add an anticipated 12 personnel to the 180 man workforce already employed at WPP. This increase provides a net positive economic impact for the Warrick county. See additional discussion in Section 4.6.

Land

The NOXSO Process and SRU will occupy less than 1.0 acre of the approximately 600 acre Alcoa site. The land required for this development is presently owned and occupied by WPP.

The project will neither require additional off-site property nor disturb present WPP operating conditions.

Miscellaneous Resources

NOXSO Sorbent

Approximately 640 tons of sorbent will be required per year to operate the NOXSO Process. It will be stored on-site in a 14 day capacity storage bin. No difficulty is anticipated in supplying the necessary amount of sorbent.

Alumina powder is the primary raw material for the sorbent. The powder is manufactured by W. R. Grace and others. The raw materials used to produce the powder are caustic soda (NaOH), alumina trihydrate ($\text{Al}_2\text{O}_3 \cdot 3\text{H}_2\text{O}$), and sulfuric acid (H_2SO_4). These chemicals are commodity products which are readily available in the United States. Grace production capacity, and the production capacity of other potential sorbent suppliers for the alumina powder, are orders of magnitude greater than the consumption rate of the NOXSO Process. There are sufficient raw materials and production capacity to meet the demonstration project requirements of the NOXSO Process.

Steel

The project will require approximately 387 tons of structural steel. The quantity required is relatively insignificant in terms of the supply and inventory of the numerous regional steel service centers. No significant changes in the availability of structural steel are projected for the scheduled construction period.

Concrete

The project will require approximately 5,154 cy of concrete. Concrete is currently available on demand from numerous regional building material suppliers. No significant changes in the availability of concrete are projected for the scheduled construction period.

4.2.3 NDP Demolition Impacts

Following the two-year operation phase the NDP at WPP will be operated commercially and thus demolition will not be required.

4.2.4 Sulfur By-Product Generation Impacts

Liquid sulfur will be produced at a rate of 2.1 tons/hr from the SRU. The sulfur will be stored in an above ground, steam-heated storage tank with a 10 day capacity. The liquid sulfur will be shipped by rail to Charleston, Tennessee where it will be used as a feed stock by the liquid

SO₂ plant. The approximately 16,060 tpy of sulfur produced by the SRU at WPP will account for less than 0.2% of the domestic sulfur market and thus will not adversely effect the sulfur market.

4.3 Waste Disposal

Summary

WPP currently generates two primary waste streams - bottom ash and fly ash. As previously discussed in Section 2, a total of approximately 55,000 lbs/hr or 217,000 tons of ash are sluiced to the ash ponds annually. Of this total about 80% is fly ash and the balance is bottom ash. Solid waste from the NDP will be classified as both non-hazardous and hazardous. The principal sources of non-hazardous solid waste are the attrited NOXSO sorbent and spent SRU sulfur converter catalyst. The principal source of hazardous waste during operation of the NDP are the spent hydrogenation catalyst and the fouled heat transfer fluid from the SRU. These hazardous wastes will be returned to the vendor for reclamation. Construction related activities will generate hazardous materials such as paint and solvent wastes.

4.3.1 NOXSO Process Construction Impacts

Paints, solvents and other primarily petroleum-based construction products will be purchased in quantities so that their on-site consumption minimizes the generation of potentially hazardous wastes. Although an exact estimate can not be accurately made, the quantity of these wastes is believed to fall within the RCRA Small Quantity Generator restrictions. Any hazardous wastes generated will be treated and/or disposed of at a licensed facility. It is not anticipated that the NDP will generate any acutely hazardous waste.

Miscellaneous construction debris including scrap steel, rubble, wood, etc. will be appropriately characterized for proper disposal at either a salvage yard or licensed construction landfill.

4.3.2 NOXSO Process Operation Impacts

A limited amount of attrited sorbent, about 5 lbs/hr, will escape collection in the baghouse and will exit with the "clean" flue gas from stacks 1 and 2. However, TSP and PM₁₀ annual emissions from Unit 2 will decrease due to the removal of entrained coal fly ash in the baghouse downstream of the NOXSO adsorbers. These emissions were discussed in Section 4.1.1.2.

The material collected in the baghouse will be returned to the ash sluice lines. After mixing with the bottom ash and fly ash in the ash sluice lines, the sorbent will ultimately be deposited in the ash disposal ponds. Any potential ecological impact from these emissions are addressed in Section 4.5.1.4, Toxicity and Environmental Fate of Attrited Sorbent. The attrited sorbent sent to the ash ponds accounts for less than 0.4% of the total ash flow to the ash ponds. The attrited sorbent is composed of SiO₂, Al₂O₃, Na₂O, and SO₃ which are compounds found in bottom and fly ash. Thus, as shown in Table 4-4, the composition of the mixture of ash and sorbent in the ash ponds is virtually indistinguishable from the "pure" bottom ash and fly ash

Table 4-4 Summary of Compositional Change

Component	Ash Mixture	Attrited Sorbent	Ash & Sorbent
Silicon as SiO ₂	44.49	6.00	44.38
Aluminum as Al ₂ O ₃	18.96	83.60	19.15
Iron as Fe ₂ O ₃	23.32	0.00	23.25
Calcium as CaO	7.11	0.00	7.09
Magnesium as MgO	0.81	0.00	0.81
Sodium as Na ₂ O	0.48	6.70	0.50
Potassium as K ₂ O	2.02	0.00	2.01
Titanium as TiO ₂	1.01	0.00	1.01
Phosphorus as P ₂ O ₅	0.36	0.00	0.36
Sulfate as SO ₃	1.36	3.70	1.37
Manganese as MnO	0.08	0.00	0.08
Note: Ash composition based on Squaw Creek coal.			

mixture. In addition, this mixture is realistically within the normal tolerances of ash quality due to differences in coal composition as determined by a NOXSO Corporation ash study.

4.3.3 Sulfur Recovery Unit Impacts

The catalyst used in the sulfur converter beds of the SRU, approximately eight tons, is an alumina silicate (Al₂O₃Si) substrate similar to the NOXSO sorbent. Life expectancy of the catalyst is upwards to four years - exceeding the two year operation phase of the NDP. No hazardous constituents are anticipated to be adsorbed on the catalyst and the catalyst itself is not classified as a hazardous material. Regeneration of the catalyst is technically feasible but is not economical given the relatively small quantity and material handling/transportation concerns. The used catalyst will be properly disposed of in accordance with the waste analysis and Federal and State solid waste regulations.

The Hydrogenation Reactor in the SRU contains approximately three tons of cobalt-molybdenum on alumina catalyst. The typical life for this type of catalyst, in this type of service, is two to three years. The spent catalyst would be classified as hazardous waste and will be sent to a catalyst reclaimer or disposed of at an approved landfill according to federal and state solid waste regulations.

The Hydrogenation Reactor is cooled using DOWTHERM Q heat transfer fluid. Fouled or contaminated heat transfer fluid will be considered hazardous waste. DOW, as a

CHEMAWARE (SM) service, maintains a fluid credit program whereby the used or fouled heat transfer fluid may be returned. Another option, in addition to returning the fluid to DOW, is to send the fluid to permitted incinerators for ultimate disposal.

4.4 Water Quality Impacts

Summary

Construction and operation of the NDP will have no significant impact on groundwater or surface water quality. The operating mode of the NDP will virtually eliminate the possibility of harm to the quality of waters surrounding WPP. Although possible, National Pollutant Discharge Elimination System (NPDES) permit modifications are not expected. Indiana Department of Environmental Management (IDEM) officials will be informed of the wastewater additions as a result of the NDP. The following discussion reviews water quality impacts for both components of the NDP.

4.4.1 NDP Construction Impacts

Groundwater

The potable groundwater aquifers in the immediate area of the plant occur in the Ohio River Alluvium. During construction, environmental impacts resulting from the infiltration of surface waters should be negligible due to both the relatively short duration of construction/earth work activities and the size of affected area. Foundations for process equipment will have footings in the alluvium/till, or will rest on pilings driven to bedrock. The risk to groundwater from surface infiltration through fractures or channeling around foundations will be minimized using generally accepted construction and installation methods which normally minimize the flow of water around foundations to insure structural integrity.

Surface Water

A slight increase in run-off may occur during construction. Soil loss will be controlled during construction by berming, silt fencing, netting, wetting, and other general construction practices which are typically used to prevent erosional loss.

4.4.2 NDP Operation Impacts

Groundwater

No process or cooling water will be discharged into groundwater aquifers beneath the site. Due to the indistinguishable nature of the chemical composition of the ash and attrited sorbent, the NDP will neither add to nor change current groundwater impacts occurring at the ash ponds.

Surface Water

Supply

Surface water used by the WPP facility is diverted from the Ohio River. River water is used primarily for once-through cooling purposes and ash sluicing at WPP. In 1993, on average, WPP diverted 444 mgd of surface water which was returned to the Ohio River.

Discharge

All wastewater discharges from WPP are to the Ohio River and are monitored by AGC as required under their existing NPDES permit. The SRU will generate a small amount of industrial wastewater from condensate and waste heat boiler blowdown, about 4 gpm or 5.8 thousand gallons per day. The NOXSO Process itself does not generate any wastewater.

SRU condensate will be generated at a rate of approximately 1 gpm from reheating the feed gas stream. Blowdown from the SRU waste heat boiler will be generated at a rate of approximately 3 gpm. The characteristics of the SRU wastewater will be typical of boiler blowdown from the WPP since the same feed water is used for the SRU. Wastewater from the SRU will be commingled with the WPP boiler blowdown, monitored, treated, and discharged in accordance with the NPDES permit discharge limitations for Outfall 103. As shown in Table 2-5, the average flow from Outfall 103 is 9.22 mgd and WPP and Warrick Operations total average water discharge is 315 to 465 mgd; thus, no significant adverse impacts to surface water quality are anticipated from the slight increase in wastewater generated from this source.

Stormwater

Stormwater run-off from the NDP will be generated from roof drains, paving, and other miscellaneous surface facilities. Slight increases over the baseline conditions in run-off volume are anticipated from these artificial surfaces. The characteristics of this stormwater are not anticipated to vary from present sources. Storm sewers in the vicinity of the proposed project are designed to adequately handle this slight increase in volume. An estimated discharge quantity can be determined once preliminary design is completed.

Stormwater sewers are directed to the coal pile run-off pond and pumped to the fly ash pond for ultimate discharge through Outfall 103. No significant adverse impacts to surface water quality are anticipated from this slight increase in stormwater discharge.

Thermal

The NPDES thermal effluent limitations have been suspended due to favorable thermal demonstration studies submitted by Alcoa to IDEM. (Ref. 1) The waiver is valid as long

as there is not a significant increase in the thermal discharge or heat rejection rate from the Alcoa plant. Warrick Operations and WPP average 315 mgd to 465 mgd of wastewater discharge to the Ohio River. The proposed project will increase the daily discharge by about 5,800 gallons and thus will not significantly impact the thermal discharge from the WPP.

4.5 Ecological Impacts

Summary

The greatest concern for possible ecological impacts as a result of the NDP are attrited sorbent emissions to nearby land and water resources. No significant threat or ecological impact is foreseen from construction or operation of the project. This sub-section evaluates this threat by an examination of existing scientific references, including on-line computer databases.

4.5.1 Construction Impacts

The WPP site was constructed in the mid-1960's and has been used continuously by the utility since then. In addition, as discussed in Section 3.3.1.4, a mitigation agreement was signed with the Army Corps of Engineers in 1980 which confirmed that no wetlands, other than those permitted, existed on the WPP property. The agreement further states that "any future use by Alcoa of any real property at the facilities shall not require a permit application as a wetland pursuant to Section 404 or the 404 Regulations."

The NOXSO Process and SRU structures will require about an acre of unvegetated, previously disturbed area within the present utility property boundaries. Therefore, neither plant and/or wildlife habitats nor wetland areas will be disturbed or encroached upon by construction of the NDP.

4.5.2 Operation Impacts

Emissions and discharges associated with the project will have negligible adverse impacts on ecological systems. The following sub-section discusses several aspects considered in review of the ecological impacts of the NDP, including: possible routes of exposure, likely receptor population, characteristics of the primary sorbent constituents, i.e., toxicity, and the ecological impact (fate) of attrited sorbent. The sub-section was developed from a literature review of available EPA guidance documents and research conducted on the environmental impacts of power plant emissions, primarily related to the release of fly ash and its chemical constituents.

Possible Routes of Exposure

A route of exposure, i.e., exposure pathway, is the course a chemical or physical agent takes from the source to the exposed receptor, typically a human. The most significant pathways are determined through an analysis of the source and receptor locations, types of releases, and activity patterns of the potentially exposed population. (Ref. 2)

An exposure pathway generally consists of four elements:

- A source and mechanism of release,
- A retention or transport media,
- A point of potential human contact with the contaminated medium (i.e, exposure point),
- An exposure route at the contact point.

The primary route of exposure to emissions from the NDP will be through contact with contaminants released to the atmosphere. The primary contaminant of concern is attrited sorbent, which is released from existing stacks 1 and 2. This material is transported (dispersed) to the exposure point (receptor) by the air.

Receptor Population

EHSS receptors are those communities, including human, animal, and plant, which may come in contact with the chemicals which are emitted by the proposed project. This receptor population will primarily include waterborne organisms contacted within the Ohio River and the somewhat distant population contacted by air dispersion of emitted attrited sorbent. These receptors will also include entities which are indirectly affected due to economic changes that may result because of the project.

Typical environmental receptors will include various biota indigenous to the southwestern quadrant of Indiana. Specifically, Section 3, which discusses the *Existing Environment*, reviews animal and plant communities common to the surrounding area. Animal receptors will most likely be exposed to attrited sorbent through inhalation of airborne particulate. Plants and other biota may experience surface contamination due to deposition of particulate. In addition, biotic populations can potentially serve as pathways for human exposure. These vector organisms, i.e., those organisms which ultimately direct exposure of hazardous materials to human receptors, may include agricultural crops, agricultural livestock, and populations of fish or mammals obtained through sport fishing or hunting.

However, the general theoretical relationships used to determine the concentration of hazardous substances at human exposure points is currently unavailable. This is because such relationships, including metabolic rate of the vector organisms and bioavailability of the substances, are highly specific to individual ecologies, biotic species, hazardous substances, and human activities associated with the biotic species involved. (Ref. 3)

Human receptors are of most importance in regard to health, safety, and socioeconomic concerns. Human receptors, like animals, will most likely be exposed to attrited sorbent through inhalation of airborne particulate. As mentioned above, additional exposure may result from contact with vector organisms.

Due to the stack height, the flue gas temperatures and velocities, and associated dispersion characteristics the populations most likely to be affected by attrited sorbent emissions from the NOXSO Project are several miles away from the facility. Therefore, the emissions from the

proposed project, as well as WPP, should be considered as regional sources of atmospheric contamination, rather than local point-sources.

4.5.3 Atmospheric Dispersion Modelling

Due to the NDP's positive effect on the air quality, atmospheric dispersion modelling is not required. As discussed in previous sections, and shown in Tables 4-1 and 4-2, the NDP will reduce emissions of SO₂ by 94%, NO_x by 73%, TSP by 88%, and PM₁₀ by 83%. The reduced pollutant emissions will result in lower maximum ground level concentrations. Also, as discussed in Section 4.1.1.2, since the effect of the NDP on the flue gas plume rise is minimal, the location of the maximum ground level concentrations of pollutants should remain the same.

In addition, the emission of NOXSO sorbent does not introduce any new compounds into the environment. The NOXSO sorbent is composed of some of the same compounds found in coal fly ash: SiO₂, Al₂O₃, Na₂O, and SO₃. As shown in Table 4-5, the emissions of these chemical compounds, and other compounds found only in fly ash, are reduced due to the NDP. The non-toxicity of the NOXSO sorbent is discussed in the following section.

Table 4-5 Emission of Fly Ash Chemical Compounds

Chemical Compound	Base Case	With NOXSO		
	Fly Ash (TPY)	Fly Ash (TPY)	Sorbent (TPY)	Total (TPY)
Silicon as SiO ₂	133.7	7.9	1.2	9.1
Aluminum as Al ₂ O ₃	57.0	3.4	16.0	19.4
Iron as Fe ₂ O ₃	65.8	3.9	0.0	3.9
Calcium as CaO	19.6	1.2	0.0	1.2
Magnesium as MgO	2.4	0.1	0.0	0.1
Sodium as Na ₂ O	1.5	0.1	1.3	1.4
Potassium as K ₂ O	6.2	0.4	0.0	0.4
Titanium as TiO ₂	3.1	0.2	0.0	0.2
Phosphorus as P ₂ O ₅	1.1	0.1	0.0	0.1
Sulfate as SO ₃	4.6	0.3	0.7	1.0
Manganese as MnO	0.2	0.0	0.0	0.0
Total	295.3	17.4	19.2	36.6

4.5.4 Toxicity and Environmental Fate of Attrited Sorbent

No research is currently known which directly addresses the toxicity and fate of attrited sorbent per se. However, the sorbent is not subject to Toxic Substance Control Act. Three items considered in assessing the potential of attrited sorbent to produce human health or environmental effects are:

- The potential for human or environmental receptors to be exposed to attrited sorbent.
- The potential for each attrited sorbent constituent chemical (Na_2SO_4 , SiO_2 , Al_2O_3 , and Na_2O) to produce a toxic effect on exposed receptors.
- The potential for particulate matter to produce a toxic effect on exposed receptors due to inherent particulate morphology or mass loading.

Human Toxicity Summary

Human receptors could potentially be exposed to extremely low levels of attrited sorbent constituents. However, as discussed above, NOXSO sorbent contains only chemical compounds found in fly ash and WPP Unit 2 emissions of these chemicals will be decreased due to the installation of the NDP. No sorbent constituent is known to be a carcinogen and therefore each is assumed to have a threshold dose, below which no adverse toxic effect is expected to occur. The risk assessment-based Ambient Air Level Goals (AALGs) derived in this document for each constituent chemical approximate these threshold levels. Maximum ground level concentrations for each of these chemicals are expected to decrease from current baseline levels and to be orders of magnitude lower than any toxicity threshold value.

Environmental Impact Summary

Environmental receptors will be exposed to exceedingly small levels of attrited sorbent constituents emitted during the NDP. However, as discussed previously, NOXSO sorbent contains only chemical compounds found in fly ash and WPP Unit 2 emissions of these chemicals will be decreased due to the installation of the NDP. Due to the solubility characteristics of some attrited sorbent constituents, it is felt aquatic ecosystems have the greatest potential to be affected if sufficiently high levels of soluble components could be deposited. Using an extremely severe, and perhaps worst case, deposition and exposure scenario, no negative impact to any ecosystem or individual organism can be identified.

4.5.5 Human Exposure Potential

On-site

Attrited sorbent will be present in ash (bottom and fly) contained in on-site ash ponds. Because ash is sluiced into the ash ponds, it will be deposited wet; for this reason, fugitive air emissions are not expected to occur from the ponds.

Off-site

The point of maximum off-site human exposure will be the point of highest PM₁₀ ground level concentration.

4.5.6 Human Health Issues

Air quality standards for particulate emissions are the only regulatory criteria applicable to attrited sorbent (or its constituent chemicals). There are no hazardous air pollutant ambient air quality standards which apply to, and are based on, the toxicity of individual sorbent constituents. All potential toxic effects identified in the literature for constituents of attrited sorbent are non-cancer, systemic toxicity effects.

In the absence of promulgated risk-based ambient air standards, reference doses must be derived against which actual or modeled concentrations can be compared to assess the potential for adverse health effects. Such reference levels are exposure concentrations below which no adverse health effect is expected to occur in a general population of humans, including sensitive subgroups. Data sets on non-cancer health effects from exposures to chemicals are highly varied in scope and in the case of many chemicals, incomplete or virtually absent (Ref. 4). An attractive methodology currently under consideration by several states for the development of regulatory Ambient Air Levels (AALs) guides the development of media-specific, risk assessment-based, Ambient Air Level Goals (AALGs) which are similar in concept to drinking water Maximum Contaminant Level Goals (MCLGs)--(Ref. 5). AALGs, like drinking water MCLGs, are different from promulgated standards in that they are based solely on health effects. AALGs are media specific (ambient air), and do not include consideration of technical, economic, or analytical feasibility. Exposure to chemical concentrations below AALGs are not expected to have adverse health effects in a general population of humans, including sensitive subgroups. A numerical AALG for one sorbent constituent, sodium sulfate, has been calculated (Ref. 5). AALGs for other sorbent constituents, expected to be emitted during the NDP, have been inferred from relevant AALGs or calculated from toxicity data obtained from primary literature sources and/or secondary electronic database sources.

4.5.7 Human Health Based Chemical Profiles and AALGs

Warrick County is in attainment for TSP. TSP emissions from WPP are primarily fly ash and, as discussed in Section 4.5.1.6, air quality standards for particulate emissions are the only regulatory criteria applicable to attrited sorbent (or its constituent chemicals) and is the basis for calculating the AALGs. Therefore, current ground level concentrations of the chemicals contained in fly ash are expected to be less than the following AALGs. As discussed previously, and shown in Table 4-6, the NDP will reduce the emissions of these chemical compounds and ground level concentrations can be expected to decrease. The AALG's of the chemical compounds found in both fly ash and attrited NOXSO sorbent are provided below as reference material.

Silicon Dioxide, amorphous (SiO₂) (CAS #7631-86-9)

While crystalline silicon dioxide can cause the fibrogenic lung disease known as silicosis, attrited sorbent contains amorphous silicon dioxide which is not fibrogenic and has extremely low toxicity (Ref. 6). The amorphous form found in attrited sorbent is exceedingly stable under extreme temperature and will not convert to a crystalline form under NDP operating conditions (Ref. 7). Silicon dioxide is practically insoluble in water or most acids and will only react rapidly with strong, fluorinated oxidizers.

Amorphous silicon dioxide acts as a desiccant when ingested. If enough water is consumed to prevent tissue dehydration, no adverse effects are known. Silicon dioxide is approved by the FDA as a food additive to prevent caking. The FDA allows foods to contain up to 2% silicon dioxide.

Summary: Silicon dioxide has very low-order toxicity. It is an inorganic solid and would exist as an aerosol or dust. Adherence to the current NAAQS for particulate matter would be protective of the health of the general public. The present primary (and secondary) standards for particulate matter are 150 $\mu\text{g}/\text{m}^3$ (no more than one exceedance per year) as a 24-hour TWA and 50 $\mu\text{g}/\text{m}^3$ annual arithmetic mean, both measured as PM₁₀.

AALG: 150 $\mu\text{g}/\text{m}^3$ 24-hour TWA (as PM₁₀)
50 $\mu\text{g}/\text{m}^3$ annual arithmetic TWA (as PM₁₀)

Aluminum Oxide (Al₂O₃) (CAS #1344-28-1)

Aluminum oxide is a common abrasive used on sand paper and is not generally regarded as an industrial toxicant. Aluminum oxide is practically insoluble in water or most acids and will only react rapidly with strong fluorinated oxidizers. Occupational inhalation of large quantities of fine particles of Al₂O₃ has resulted in a lung disease known as Shaver's disease. Aluminum oxide has been used as an experimental gel for sequestering excess phosphate in kidney dialysis patients.

No data have been found to implicate aluminum oxide as a carcinogen or mutagen. No reproductive studies in humans or animals have been found. There appear to be no effects from low level exposures to aluminum oxide dust other than those expected of a nuisance dust.

Summary: Aluminum oxide has very low-order toxicity. It is a crystalline inorganic solid and would exist as an aerosol or dust. Adherence to the current NAAQS for particulate matter would be protective of the health of the general public. The present primary (and secondary) standards for particulate matter are 150 $\mu\text{g}/\text{m}^3$ (no more than one exceedance per year) as a 24-hour TWA and 50 $\mu\text{g}/\text{m}^3$ annual arithmetic mean, both measured as PM₁₀.

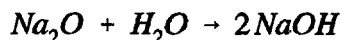
AALG: 150 $\mu\text{g}/\text{m}^3$ 24-hour TWA (as PM₁₀)
50 $\mu\text{g}/\text{m}^3$ annual arithmetic TWA (as PM₁₀)

Sodium Oxide (Na₂O) (CAS #12401-59-3)

Na₂O is very reactive with water and combines rapidly to form sodium hydroxide (NaOH)- (Ref. 8). Due to the presence of atmospheric and combustion-derived moisture, the conversion of Na₂O to NaOH is expected to be rapid and virtually complete at the stack exit. NaOH decomposes in the presence of carbon dioxide (CO₂) to form sodium carbonate (Na₂CO₃). The latter decomposition is expected to be relatively slower. Potential receptors could be exposed to NaOH and Na₂CO₃.

Both NaOH and Na₂CO₃ form alkaline solutions with water and are respiratory irritants in solid form. The critical effect for inhalation exposure to either chemical is irritation. NaOH is considered a strong irritant while Na₂CO₃ is considered a mild irritant (Ref. 9). Using the assumption that Na₂O emissions will be converted completely to NaOH will produce a worst-case exposure scenario with which to evaluate the maximum potential toxic effect.

An AALG of 0.04 mg/m³ for NaOH has been derived (Ref. 5) The occupational American Conference of Governmental Industrial Hygienists (ACGIH) ceiling TLV of 2 mg/m³, with an uncertainty adjustment (divisor) of 50, was used to arrive at the AALG for NaOH (i.e. 0.04 mg/m³). NaOH will be produced from Na₂O emissions according to the following chemical reaction:



The equivalent mass of Na₂O capable of decomposing to form 0.04 mg of NaOH, is 0.03 mg (30.0 µg).

Summary: Due to rapid atmospheric decomposition of Na₂O to NaOH and because NaOH poses the most significant health risk, the AALG for NaOH has been used and adjusted to an equivalent weight of Na₂O. A protective AALG does not require allocation of an exposure proportion to air because there is no cumulative effect for a simple irritant.

The occupational TLV for inhalation is used to derive the final AALG because such an occupational value is based on the most complete human database for inhalation exposures.

AALG: 30 µg/m³ (TLV-based) ceiling

Note: The U.S. EPA recently completed an evaluation of NaOH with respect to the need to regulate NaOH emissions under the Clean Air Act (EPA 1988). It was concluded that "given the paucity of data regarding systemic or acute health effects and the low potential for exposure to high concentrations of sodium hydroxide (due to its rapid atmospheric degradation), it is unlikely that routine emissions of sodium hydroxide pose a public health risk."

Sodium Sulfate (Na_2SO_4) (CAS #7757-82-6)

Sodium sulfate is used as a saline cathartic in humans with a usual therapeutic dose of 214 mg/kg for a 70 kg person. It has been concluded that sodium sulfate does not pose a significant toxicity hazard except at high doses where dehydration may occur due to the cathartic effect ($>10,000$ ppm in chickens) -- (Ref. 10).

No data were found to implicate sodium sulfate as a carcinogen or mutagen. In one study, intraperitoneal injection (60 mg/kg) of pregnant mice resulted in decreased maternal body weight gain and an increase in pup skeletal deformities (Ref 11). In another study where large doses were administered by Gavage (2800 mg/kg) on gestation days 8 through 12, there was no adverse effect on maternal health or neonatal survival and there was a significant increase in pup birth weight (Ref. 12).

Summary: Sodium sulfate has very low-order toxicity. It is an inorganic solid and would exist as an aerosol or dust. Calabrese and Kenyon recommend that adherence to the current NAAQS for particulate matter would be protective of the health of the general public. The present primary (and secondary) standards for particulate matter are $150 \mu\text{g}/\text{m}^3$ (no more than one exceedance per year) as a 24-hour TWA and $50 \mu\text{g}/\text{m}^3$ annual arithmetic mean, both measured as PM_{10} .

AALG: $150 \mu\text{g}/\text{m}^3$ 24-hour TWA (as PM_{10})
 $50 \mu\text{g}/\text{m}^3$ annual arithmetic TWA (as PM_{10})

Sodium Nitrate (NaNO_3) (CAS #7631-99-4)

Nitrogen oxides are physically adsorbed on NOXSO sorbent sodium sites (Na_2O) rather than chemically reacting with the sodium to form Sodium Nitrate. Once the attrited sorbent is emitted to the atmosphere, or collected by the baghouse and combined with ash in the ash ponds, the weak, physical bond will break and the nitrogen oxides will desorb from the sorbent.

4.5.8 Ecological Issues

The available scientific data relating to ecological effects of sorbent constituents are incomplete. For this reason a qualitative assessment of potential ecological impact has been made using semi-qualitative estimates of cumulative sorbent constituent deposition.

Due to the solubility characteristics of some sorbent constituents, aquatic ecosystems have the greatest potential to be affected if sufficiently high levels of soluble sorbent constituents could be deposited in the water column. In the case of NDP emissions, the most severe deposition and exposure scenario assumes all particulate emissions could be deposited in a relatively small water-shed area and that all soluble particulate matter would enter the Ohio River. This scenario also assumes that all soluble sorbent constituents deposited in the WPP ash ponds enter the Ohio River. Based on this highly conservative scenario, there does not appear to be any significant effect on any ecosystem. The basis for this conclusion is presented below for each sorbent constituent.

4.5.9 Environmental Fate of Sorbent Constituents

Silicon Dioxide, amorphous (SiO₂) (CAS #7631-86-9)

SiO₂ is naturally occurring and is ubiquitous in soil and rock. It is exceedingly stable and virtually insoluble in water. With the exception of hydrofluoric acid, SiO₂ is insoluble in aqueous acids at room temperature (Ref. 8).

Summary: SiO₂ is expected to be inert in the environment, and once deposited on land, could enter an aquatic ecosystem only by erosion. In addition, the NDP will reduce WPP Unit 2 emissions of silicon dioxide by about 93%. No ecological effects are expected from this chemical.

(Note: Quartz and many other rocks contain mainly SiO₂).

Aluminum Oxide (Al₂O₃) (CAS #1344-28-1)

Al₂O₃ is naturally occurring. It is among the most common forms of aluminum found in nature. Al₂O₃ is a stable compound and does not readily decompose in the environment. It is very hard and is insoluble in water. It is nearly insoluble in acid and alkali solutions. (Ref. 13)

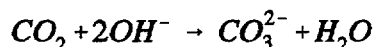
Summary: Al₂O₃ is expected to be inert in the environment, and once deposited on land, could enter an aquatic ecosystem only by erosion. No adverse ecological effects are expected from this chemical.

Sodium Oxide (Na₂O) (CAS #12401-59-3)

Na₂O is a white amorphous powder that will react with atmospheric water to form NaOH by the following chemical reaction:



NaOH is strongly alkaline due to its OH⁻ moiety. In solution with water, as would be expected after deposition, hydroxides of sodium avidly react with ambient CO₂ to produce the corresponding carbonate by the following chemical reaction (Ref. 14):



NaOH in air will react with ambient CO₂ to form Na₂CO₃ which will then dissociate in water to form carbonate, as well.

Hardness (measured as CaCO₃) can directly or indirectly effect water toxicity to fish. Water quality data at river mile 776 has shown a hardness ranging from 190 to 110 mg/L (as CaCO₃) (Ref 15). If all the Na₂O from the attrited NOXSO sorbent (42.8 tpy) could dissolve uniformly

over one year into the Ohio River at the mile point 792 (128,000 cfs), the mean contribution to the hardness of the river would be about 5.5×10^{-4} mg/L.

Summary: It is not possible for all the Na_2O from the NDP to be either deposited in the Ohio River basin or leach out of the attrited sorbent deposited in the WPP ash ponds. Additionally, the ability of carbonate generated from the decomposition of Na_2O could not significantly alter surface water hardness; therefore, no adverse ecological effects are anticipated.

Sodium Sulfate (Na_2SO_4) (CAS #7757-82-6)

Na_2SO_4 is naturally occurring. It is a component of consumer products such as laxatives, and antacids. Na_2SO_4 is very soluble in water. It is a neutral salt that generally will not undergo further reaction. In the environment, certain bacteria are capable of reducing sulfate to elemental sulfur which is relatively inert in the environment (Ref. 13).

Na_2SO_4 was found to be toxic in chickens by ingestion at concentrations in excess of 10,000 mg/L, probably as a result of dehydration due to its cathartic effect (Ref. 10). The LC_{50} was reported to be 13,500 mg/L for bluegill (96 hour, static)-- (Ref 9). If all the Na_2SO_4 from the attrited NOXSO sorbent (23.6 tpy) could dissolve uniformly over one year into the Ohio River at mile point 792 (128,000 cfs), the mean concentration would be about 1.9×10^{-4} mg/L.

Summary: It is not possible for all the Na_2SO_4 from the NDP to be either deposited in the Ohio River basin or leach out of the attrited sorbent deposited in the WPP ash ponds. Even if this was possible, the mean potential Na_2SO_4 concentration would be 100 million-fold lower than any toxic effect reported in the literature; therefore, no adverse ecological impacts are expected.

Sodium Nitrate (NaNO_3) (CAS #7631-99-4)

Summary: As discussed in Section 4.5.1.7, NO_x adsorbed on the attrited sorbent will desorb. Ultimate sorbent deposition in the environment will not include the sodium nitrate compound.

4.6 Socioeconomic Impacts

Summary

Overall, the NDP should have a beneficial effect on the Warrick County area. Construction and operations personnel will increase employment in the local area. Steel, concrete, and other building materials will be locally supplied. The impacts of construction and operation of the NDP are discussed below. No significant adverse socioeconomic impacts are anticipated from the NDP.

4.6.1 NDP Construction Impacts

The construction of the NDP should not have a significant impact on the local area as supported by the following findings.

Traffic Impacts

Warrick Power Plant currently receives about 500 coal truck deliveries, 150 commercial and package deliveries, and 1200 passenger vehicle round trips per week. Construction-related trips have been estimated based on the number of construction workers and equipment deliveries anticipated over the 17-month construction period. Assuming a maximum of 160 construction workers will be employed, conservatively assuming 30 equipment deliveries per day and a 5-day work week, about 950 additional weekly trips into and out of the plant are expected. Based on these estimates, truck deliveries are expected to increase by 19% while passenger car traffic is expected to increase by 70%.

Traffic will not be adversely affected within the power plant. The roads are built to accommodate the weight of the required equipment and shuttles are provided from the employee parking lot on the west side of the facility to the construction site. No new roads will need to be constructed. Previous construction/maintenance projects at WPP employing a comparable number of workers have had little or no impact.

As mentioned in Section 3.5.2, access to the site is via the SIGECO road off of Route 66. On average, 10,700 vehicles were counted per day on Route 66 just east of the SIGECO road while on average 13,490 vehicles were counted per day on Route 66 just west of the SIGECO road. Assuming all of the construction traffic volume comes from the west on Route 66, the average daily traffic volume will increase by about 1%.

Noise

Potential socioeconomic noise impacts during construction are expected to affect two classes of people: (1) the workforce and (2) the residents in the surrounding community. Based on the following findings, no adverse noise impacts are anticipated from the NDP during construction.

- **Workforce**

The noise associated with construction activities will cause a small increase in noise levels in adjacent areas. These noise levels should not exceed 85 to 88 dBA at distances of 250 to 500 feet away from the proposed construction activities. With the exception of pile driving, the noise levels will not be noticeably higher than background noises at distances greater than 500 feet. The noise levels from pile driving will be intermittent and will not exceed the OSHA permissible noise exposure limit of 140 dBA for impact noise. No adverse noise impacts on the workforce are anticipated from the NDP.

- Public

The closest residential receptor is about 1.5 miles from the proposed project site. Typical construction activities are not expected to result in noise levels above the normal daylight nuisance noise level. Construction activities which have the potential for generating significant amounts of noise, i.e., pile driving, will be limited to daylight hours. Therefore, adverse noise impacts are not expected to the surrounding community.

Public Services

Electricity, water, and a sanitary sewer system are currently on-site and will be sufficient to meet construction needs. A natural gas supply line is available. Local fire and police departments and health care facilities are not anticipated to be adversely affected.

Land Usage

Construction of the NDP will take place within the existing plant boundaries and not encroach on any surrounding public or private property. Land usage is not expected to be adversely affected.

- Federally Endangered Species

The DOE has been advised by the U.S. Department of Interior, Fish and Wildlife Service that the proposed project would have no adverse effect on any Federally endangered species or wetlands habitat (Ref. 16).

- Archeological, Cultural, & Historic Properties

The DOE has been advised by the Indiana Division of Historic Preservation and Archaeology that the proposed project would have no impact on archaeological, architectural, or historical sites listed in or eligible for inclusion in the National Register of Historic Places (Ref. 17).

Population

Although a small number of workers may take up residence in hotels or apartments within the Warrick County area during construction, no extended change in population is expected from the construction of the NDP.

Health and Safety

Potential socioeconomic health and safety impacts during NDP construction are anticipated to affect both the on-site workforce and the surrounding community. Based on the following findings and implementation of appropriate engineering controls, no significant adverse health and safety impacts from construction are anticipated.

- Workforce

A construction safety program will be written, and implemented for the NDP to minimize the occurrence of accidents. Specific standards set by OSHA will be targeted for training and inspection during the construction work. A written hazard communication program will be established to inform craftsmen of the hazard potential from chemicals used on-site.

The education, engineering, and enforcement components of the MK-Ferguson safety program have been used to lower the rate of accidents on job sites. The workforce is educated through new-hire orientations, safety meetings and personal communications. Human engineering eliminates unsafe acts by motivating employees to "think safely." Safety engineering is used to eliminate unsafe conditions through performance of hazard reviews, site inspections, and accident investigations. Line supervisors enforce the rules of good safety practice and take disciplinary action when warranted. The workplace health and safety program deters any significant health and safety impacts to craftsmen and equipment during the construction activities.

- Public

Community health and safety impacts during construction could be anticipated from fugitive emissions or improper solid waste disposal. Fugitive dust emissions during construction work will be controlled by wetting and/or other general construction practices when site conditions have the potential to impact either adjacent on-site areas or off-site locations.

Typical construction hazardous wastes include paint and solvent wastes. All hazardous waste generated during construction will be properly containerized, temporarily stored with compatible wastes, labeled, and transported by a licensed shipper to an approved treatment, storage or disposal facility (TSDF). The transporter will be responsible for making appropriate notifications if any environmental release occurs during transportation. It is most likely that the quantity of material generated during construction activities will allow for project classification under the category of Conditionally Exempt Small Quantity Generator (CESQG). Hazardous wastes produced will be handled under the CESQG unless the on-site storage quantity exceeds 2200 lbs.

Non-hazardous solid waste generated from construction, such as scrap materials, will be disposed of in an approved industrial (waste) landfill. No adverse community impacts are anticipated from these sources during construction.

4.6.2 NDP Operation Impacts

Based on the following findings, operation of the NDP is not anticipated to have any significant adverse socioeconomic impacts.

Traffic Congestion

Warrick Power Plant currently receives about 500 coal truck deliveries, 150 commercial and package deliveries, 325 rail car deliveries, and 1200 passenger vehicle round trips per week. Sorbent deliveries are conservatively estimated at one truck load every other week. Sulfur shipping can be accommodated with approximately three rail cars per week. In addition, three full time employees per shift or 63 passenger vehicle round trips per week will be required. As a result of the proposed project the intraplant truck traffic will increase by less than 1%, rail traffic by about 1% and passenger car traffic by about 5%.

As mentioned in Section 3.5.2, access to the site is via the SIGECO road off of Route 66. On average, 10,700 vehicles were counted per day on Route 66 just east of the SIGECO road while on average 13,490 vehicles were counted per day on Route 66 just west of the SIGECO road. Assuming the all of the operations traffic volume comes from the west on Route 66 the average daily traffic volume on Route 66 will increase by less than 1%.

The transfer by rail of elemental sulfur to Charleston, TN, will be accessed in the portion of the EIV dealing with the liquid SO₂ facility.

Noise

The two receptor groups of noise generated from NDP operations are the workforce and residents in the surrounding communities. Based on the following findings, no significant adverse noise impacts from operations are anticipated.

- **Workforce**

The major sources of noise emissions from the NDP equipment are the induced draft (flue gas booster fans and sorbent cooler fans. Workforce noise is regulated by OSHA under 29 CFR 1910.25. This regulation requires engineering controls, administrative measures and hearing protection for noise exposures greater than 90 dBA for eight hours. A hearing conservation program will be implemented as required if noise exposures are greater than or equal to 85 dBA for eight hours. Annual audiogram and training will be incorporated into the hearing conservation program. Implementation of a hearing conservation program will assure that no significant adverse noise impacts on the workforce will result from the NDP.

- **Public**

The noise sources from the NDP will produce a broad band noise spectrum. The resultant noise levels will consist of a composite of sounds with none being particularly dominant. Outdoor noise propagation from operations will be further attenuated by adjacent buildings, ground barriers, trees, and the distance through the atmosphere to receptors. Typical residential nuisance noise levels of 60 dBA (day time) and 50 dBA

(night time) are not anticipated to be exceeded by NDP operations. Therefore, no significant adverse noise impacts to the surrounding community are anticipated.

Public Services

No additional public services other than those that were discussed in the construction phase, sub-Section 4.6.1.1., would be required during the 24-month operation of the NDP.

Land Usage

No additional land will be used during the 24-month operation of the NDP.

Population

No impact on the population is anticipated during the 24-month operation of the NDP.

Health and Safety

The two potential receptor groups of health and safety impacts from NDP operations are the on-site workforce and the surrounding community. The major health and safety hazards are fire or explosion hazards, primarily to the workforce, and potential exposure to methane, hydrogen sulfide and sulfur dioxide. These chemicals will be contained in the NOXSO Process regenerator and SRU. Methane, CH₄, is a fire and explosion hazard and simple asphyxiant, and hydrogen sulfide, H₂S, and sulfur dioxide, SO₂, are considered extremely hazardous. Extremely hazardous chemicals, according to the Clean Air Act, are substances that, "in the event of an accidental release, are known to cause or may reasonably be anticipated to cause death, injury, or serious adverse effects to human health or the environment." Several federal regulations establish lists of extremely hazardous substances, threshold planning quantities (TPQ), and facility notification responsibilities necessary for the development and implementation of emergency response plans. However, as discussed in Section 5.6.3, at no time will the quantities of these substances within the NOXSO Process and SRU exceed the TPQ; therefore, the proposed project is not subject to these regulations.

Hydrogen sulfide (H₂S) is a human poison by inhalation. It is a severe irritant to the eyes and mucous membranes. The concentration of 300 ppm hydrogen sulfide is immediately dangerous to life and health (IDLH). The IDLH is defined as "the maximum concentration of a substance in air from which healthy male workers can escape without loss of life or irreversible health effects under conditions of a maximum 30-minute exposure time." The Occupational Safety and Health Administration (OSHA) permissible exposure limits are 10 ppm for an eight-hour time weighted average (TWA) and 15 ppm for a short-term exposure level (STEL). H₂S is detected at very low concentrations (<1 ppm) by humans, but causes desensitization as concentration increases. SO₂ is a human poison by inhalation. It is a severe irritant of the eyes and mucous membranes. The concentration of 100 ppm SO₂ is immediately dangerous to life and health (IDLH). The OSHA permissible exposure limits are 2 ppm for an eight-hour TWA and 5ppm for a STEL. (Ref. 18)

To access the impact of the potential exposure to H_2S and SO_2 an accident analysis was performed. The analysis is consistent with DOE regulations which require an accident analysis for "environmental impacts that will not necessarily occur under a proposed action, but which are reasonably foreseeable." As discussed earlier, the extremely hazardous substances are contained in two areas of the proposed project, the NOXSO Process regenerator and the SRU. The accident scenarios investigated for each area are shown below.

Case A. NOXSO Process Regenerator

- 1) Pressure safety valve lifts and is vented to the power plant stack
- 2) Off-gas pipe failure at ground level
- 3) Regenerator vessel failure near ground level

Case B. Sulfur Recovery Unit

- 1) Pressure safety valve lifts and is vented to the power plant stack
- 2) Pipe or process vessel failure at or near ground level

Each accident scenario listed above would result in an instantaneous release or "puff" rather than a continuously emitting source, such as the emissions from a power plant stack. Accordingly, a "puff" method for estimating the worst case ground level concentration of SO_2 and H_2S was used (Ref. 19). CS_2 is present in the regenerator and SRU in very small concentrations, < 0.5 mole %, and can be excluded from the analysis. Worst case ground level concentrations were calculated at 1.2, 2.4, 3.0, 5.0, and 10.0 kilometers from the source using the following assumptions:

- Atmospheric stability class F for ground level releases.
- Safety valves will be vented to WPP stack number 2.
- Atmospheric stability class C for releases vented to WPP stack.
- The Receptor is in center line of plume, eg., no off axis dispersion of pollutants.
- Depending on the scenario, the entire regenerator vessel or SRU gas volume is released.
- The regenerator and SRU are isolated from each other in the event of an accidental release.
- Plume buoyancy is neglected.

The Level of Concern (LOC) is defined as "concentrations of an extremely hazardous substance in air above which there may be serious irreversible health effects or death as a result of a single exposure for a relatively short period of time." However, the LOC for SO_2 and H_2S have been conservatively estimated by using one-tenth of the Immediately Dangerous to Life and Health (IDLH) level published by the National Institute for Occupational Safety and Health (NIOSH). The LOC for SO_2 is 10 ppm while the LOC for H_2S is 30 ppm. (Ref 18) Ground level concentrations that exceeded the LOC for SO_2 and H_2S are shown in Table 4-6, all other ground level concentrations for each accident scenario were below the LOC. The nearest residential receptor is about 2.4 kilometers from the NDP site.

Table 4-6 Accident Scenario Ground Level Concentrations

receptor distance (km)	Case A2		Case A3		Case B2	
	SO ₂ (ppm)	H ₂ S (ppm)	SO ₂ (ppm)	H ₂ S (ppm)	SO ₂ (ppm)	H ₂ S (ppm)
1.2	68	51	58	43	12.9	32.4
2.4	12	-	11	-	-	-

The pressure safety valves (PSV) from the regenerator vessel and SRU will be vented to WPP stack 2 where any possible release would be diluted by power plant flue gas and discharged to the atmosphere. Due to the stack elevation, 400 ft, the SO₂ and H₂S are dispersed more readily than ground level releases; thus resulting in relatively low ground level concentrations. Pressure safety valves are designed to prevent the failure of process equipment, piping and vessels due to over pressurization. It is unlikely that the entire contents of the regenerator or SRU would be discharged if a PSV lifts; the PSV will close as soon as the pressure drops below the relief set point. Of the accident scenarios investigated these are the most likely to occur. However, the NOXSO Process and SRU will be designed, controlled, and operated to minimize the occurrence of the regenerator or SRU PSV lifting.

A failure of the regenerator off-gas line or vessel and SRU process piping or vessels would most likely be caused by explosion, natural catastrophe, i.e. earthquake or tornado, or metal corrosion. Inadvertently adding oxygen to the regenerator containing heated methane and hydrogen sulfide gas may result in fire or explosion. The POC hazard review identified this scenario and a redundant control and design philosophy was used to prevent a regenerator fire or explosion. A non mechanical "J-leg or L-valve", using steam as the transport gas, will be used to transport the sorbent to and from the regenerator. The design of the L-valve, and the use of steam as the transport gas, will prevent oxygen from entering the regenerator. In addition, the regenerator will be maintained at a slightly higher pressure than the sorbent heater to help prevent oxygen from being carried with the sorbent into the regenerator. The POC facility, which operated over 6,500 hours without a regenerator fire or explosion, has verified this design. A similar fire or explosion hazard exists in the SRU. The SRU technology under review for the NDP is a mature, proven process, with a history of safe operation. A similar redundant control and design philosophy will be used to minimize the occurrence of fire or explosion.

In addition, the NOXSO Process and SRU will be designed and constructed for the appropriate seismic zone and wind loadings for the Warrick County, Indiana area. The regenerator and off-gas line and SRU process piping and vessels will be constructed of materials which are resistant to corrosion. A routine maintenance program will monitor the metal thickness and integrity of these vessels and process piping to identify corrosion areas which require repair.

The relatively low operating pressure of the regenerator vessel and offgas line and SRU process piping and vessels, 2-3 psig and 5-10 psig respectively, will reduce the likelihood of vessel or pipe failure. Any leaks from this equipment will be detected by ambient area safety monitors located at ground level, throughout the NOXSO Process tower around the regenerator, and around the SRU and eliminated immediately. The area safety monitors will be installed, operated, and maintained following recommended industry practices, such as API 550 - *Manual on Installation of Refinery Instruments and Control Systems: Part II - Process Stream Analyzers; Section 10 Area Safety Monitors*.

The use of safe engineering design, leak detection, and shut-off systems will permit the operation of the NOXSO Process and SRU with minimal concern for system failure. In addition, HAZOP procedures, a coordinated process hazard evaluation/safety review, will be used to identify, evaluate and control the hazards associated with the NOXSO Process and SRU to ensure safe operation. All operations personnel will be trained to develop and maintain safe operating practices. An OSHA compliance plan will also be implemented to identify specific standards set by OSHA that require job training and related activities. Therefore, no adverse health and safety impacts on the workforce or public from operations are anticipated.

Pollution Prevention

Pollution prevention and waste minimization focus on reducing the amount and/or toxicity of pollutants generated by industrial processes. While pollution prevention is based upon controlling pollutants at their source, waste minimization also controls pollutants by process changes, as well as reuse and recycling practices. The Pollution Prevention Act of 1990 establishes a protection hierarchy of environmental management techniques, and in 1992, the EPA issued a draft Federal Sector Strategy which calls for federal agencies to lead the nation in implementing pollution prevention policies and practices.

The proposed project incorporates several pollution prevention and waste minimization principles and techniques. The most significant technique is the basis of the NOXSO Process. SO_2 and NO_x are removed from the flue gas without transfer of these pollutants to other media such as water or solid waste. SO_2 is removed from the flue gas and then converted within the SRU into elemental sulfur, a salable by-product. The NO_x is recycled to the boiler where it dissociates to elemental nitrogen and oxygen.

The sorbent used in the NOXSO Process is a non-toxic, non-hazardous material. The sorbent will be continuously regenerated and reused, while the small amount of attrited sorbent formed will be combined with fly ash, a non-hazardous waste. Another waste minimization technique inherent in the design of the proposed project is the recovery of waste heat to reduce energy requirements and ultimately, waste.

4.7 References

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Draft Environmental Information Volume for the NOXSO Demonstration Project, March 1993.

5 APPLICABLE REGULATIONS

This section describes the federal and state regulatory compliance and permit requirements for the NOXSO Demonstration Project (NDP) at the Warrick Power Plant (WPP).

5.1 Air Quality

Emission source activities at Alcoa Generating Corporation's WPP are regulated under Title 326 of the Indiana Administrative Code (IAC). Pursuant to the 326 IAC, the aggregate of all operations at the WPP constitute the source, and an individual unit within the source, such as Unit No.2, is referred to as the facility. Numerous facilities on the WPP site are subject to provisions of 326 IAC.

With respect to permitting procedures, sources are characterized as either major or non-major based on the level of emissions activity at the source. Major sources are required to obtain construction permits before constructing or modifying the source (or a facility), and are required to obtain operating permits on a periodic basis. The state is authorized to issue a single operating permit to the source, as opposed to issuing a permit to each facility, if it so chooses. For all state provisions discussed herein, the WPP site is defined as a major source of air pollutants.

In addition to 326 IAC, some of the operations at the WPP site are subject to federal requirements for regulating air pollutant emissions. Federal laws are applicable to all industrial sites nationwide and must be followed in addition to state requirements. Authority to enforce these federal laws is generally delegated to individual states which codify federal requirements into state law, as well as any other measures deemed necessary by the state to protect the public welfare. The most important federal statute to consider when evaluating requirements for air pollutant sources is the Clean Air Act (CAA). One objective of the CAA is to ensure continued attainment and maintenance of air quality at levels prescribed by the National Ambient Air Quality Standards (NAAQS). The NAAQS have been adopted for six criteria air pollutants: sulfur dioxide, nitrogen dioxide, carbon monoxide, particulate matter less than 10 microns, ozone, and lead. Each area of the country is rated with respect to the relationship between measured ambient air pollutant concentrations and the NAAQS for that pollutant. Areas with concentrations less than the NAAQS are said to be in attainment, while areas with concentrations greater than the NAAQS are said to be in nonattainment with the NAAQS. Areas for which there is insufficient information as to whether or not the NAAQS is being achieved are designated unclassifiable, although these areas are generally presumed to have acceptable air quality. The WPP is located in Warrick County which is designated as attainment or unclassifiable/attainment for all criteria pollutants except for lead (Section 3.1.2). The county has no lead designation as there is no major source in the area.

The CAA stipulates requirements in several program areas relevant to the NDP, including provisions for nonattainment, acid rain, air toxics, performance standards, and permits.

5.1.1 Nonattainment

The CAA mandates the attainment of the NAAQS through several mechanisms. With respect to Unit No. 2 at the Alcoa plant, the CAA has mandated that the Indiana Department of Environmental Management (IDEM) limit SO₂ emissions from the boiler, as well as other facilities at the site, so as to demonstrate that ambient air quality will be protected from degradation by SO₂. The IDEM has, therefore, limited the emission of SO₂ from numerous facilities at the Alcoa plant, and the result is that the area is able to demonstrate attainment of the SO₂ NAAQS as prescribed by the CAA. This mandate was accomplished through the State Implementation Plan (SIP), which currently limits SO₂ emissions from each of the four units to 5.11 lbs/mmBtu; alternate emission limits are allowed to be used if commensurate reductions are obtained from a nearby power plant.

The IDEM, Division of Air Management, controls air emissions through the issuance of a construction permit. The construction permit contains operating conditions which limit the emissions of SO₂, NO_x, and TSP. WPP currently operates under construction permit No. CP 173-2087.

5.1.2 Acid Rain

The CAA also regulates the electric generating industry in order to lower the atmospheric phases by the CAA. Phase I requires 111 power plants to reduce their SO₂ emissions to a level of 2.5 lbs/mmBtu by January 1995. In Phase II, these plants and almost all other utilities must reduce SO₂ emissions to 1.2 lbs/mmBtu by January 2000. To reduce NO_x emissions, the EPA has mandated the use of low NO_x burners and overfire technology. The overfire requirement has successfully been challenged in a recent court case. The CAA has developed a schedule of mandated reductions at affected facilities. One such major emitting facility is located at the WPP, Unit No. 4, and another is located nearby, at the Culley power plant (Warrick Units 1, 2, and 3 are exempt as they are classified as industrial boilers which do not generate electric power for the public utility grid). The Phase I acid rain provisions of the CAA require that Unit 4 reduce its emission of SO₂ to a rate of 2.5 lbs/mmBtu, approximately equal to 50 percent of its present rate. The allowable SO₂ emission rate assigned to a facility in the acid rain provisions is referred to as an allowance. Each allowance represents an annual emission of one ton. As a result of the acid rain provision, Unit 4 has been given an SO₂ emission allowance of 26,980, or 26,980 tons/yr. Unit 4 may achieve its compliance with Phase I requirements by switching to low sulfur coal. However, since Unit 4 is linked by IDEM with the Culley power plant, scrubber reductions at Culley may be sufficient to allow WPP Unit 4 to operate within its SO₂ allowance limit without switching coal.

Sites that are unable or find it economically unviable to achieve the reductions mandated by the CAA can purchase allowances from other sites. These sites may have "over complied" or voluntarily entered the CAA Acid Rain Program. The Opt-In Program of the CAA allows nonaffected sources to voluntarily enter the Acid Rain Program and receive SO₂ emission allowances. The Opt-In Program covers only SO₂ and not the other compounds covered under the CAA. Non-affected sources which opt-in will not be bound by the CAA Title IV NO_x

regulations. AGC intends to opt-in WPP Units 1, 2, and 3. A permit will be necessary from the EPA and allowances will be based on SO₂ emission levels from the mid to late 1980's.

5.1.3 Air Toxics

A number of air pollutants are regulated as toxic pollutants under the CAA. If a modification to a source results in an increase in emissions equivalent or greater than four tpy of a listed toxic pollutant reduction measures equivalent to the Maximum Achievable Control Technology (MACT) are required. The only listed air toxic potentially released by the NDP is hydrogen sulfide (H₂S). Emissions from the NDP will be less than the four tons/yr, and therefore the WPP will not be subject to any new air toxic control requirements.

5.1.4 Performance Standards

New Source Performance Standards (NSPS) exist for many industrial process categories. For example, an NSPS exists for utility boilers for which construction commenced after August 17, 1971; a separate NSPS exists for utility boilers constructed after September 18, 1978. There are no NSPS directly applicable to the NOXSO project.

40 CFR 60, Subpart J contains standards of performance for Petroleum Refineries and includes sulfur recovery plants. The regulation covers emissions of SO₂ and H₂S from these units, and requires monitoring of emissions for SO₂, reduced sulfur (compounds where sulfur has a negative valence such as H₂S) and O₃ emissions. This regulation is not applicable to the NOXSO process as it only applies to petroleum refineries.

5.1.5 Permitting

The NDP will be constructed in an area designated unclassifiable/attainment for criteria pollutants (Section 3.1.2). Existing air quality is therefore presumed to be acceptable. The most important permitting requirement to consider for areas with acceptable air quality are regulations for Prevention of Significant Deterioration (PSD). PSD applies to new major sources or major modifications at existing major sources. Because the WPP plant is a major source, PSD will apply to the proposed project if the NDP increases annual potential emissions by the following amounts (reported in tons):

carbon monoxide	100
nitrogen oxides	40
sulfur dioxide	40
PM ₁₀	15
ozone	40 of hydrocarbons
lead	0.6
asbestos	0.007
beryllium	0.0004
mercury	0.1
vinyl chloride	1

fluorides	3
sulfuric acid mist	7
hydrogen sulfide	10
total reduced sulfur	70

However, the NDP will not trigger PSD. Annual emission increases, if any, will be below the PSD threshold amount for each of the compounds listed above.

The Indiana regulations on particulate include both total suspended particulates (TSP) and PM₁₀. For PSD purposes, significant levels are set at 25 tons per year TSP and 15 tons per year PM₁₀. Maximum permissible ambient air quality levels for TSP are as follows: Primary standards -- 75 µg/m³ annual geometric mean, 260 µg/m³ maximum 24 hour average; Secondary Standards - 150 µg/m³ maximum 24 hour average. The NDP will reduce the TSP and PM₁₀ emissions from Unit 2 and thus will not trigger PSD (Section 4.1.1.2)

Alcoa believes an application for "registration" of the NOXSO process will be sufficient to satisfy Indiana air permitting requirements. Information required by IDEM would include a description of the modification including emission control equipment, and information on the nature and amount of pollutants to be emitted. Title V of the Clean Air Act will require all emissions from the WPP facility to be quantified with this data submitted to the U.S. EPA.

5.2 Land Use

The following land use issues have been discussed in previous sections of the EIV: floodplains (Section 3.3.1.3), wetlands (3.3.1.4), farmlands (3.2.3), and historic sites (3.6.1). No further notification or permits regarding these issues will be required.

5.3 Waste Disposal

The federal Resource Conservation and Recovery Act (RCRA) of 1976 establishes a comprehensive cradle-to-grave regulatory system for all solid waste (hazardous and non-hazardous). The regulations are intended to govern the management of solid and hazardous waste and include governing the treatment, storage, and disposal of such waste. For the NDP, wastes of specific concern are the ash/sorbent mixture and SRU wastes.

5.3.1 Ash/Sorbent Mixture

Under EPA regulations for identifying hazardous waste - 40 CFR 261.4(b)(4), fly ash, bottom ash, and flue gas emission control wastes generated from the combustion of coal are defined as non-hazardous solid wastes. Similarly, the Indiana Hazardous Waste Management Rules, adopted January 24, 1992, also define (and exclude) these wastes by reference to 40 CFR 261.

The addition of attrited sorbent from the NDP to the fly ash and bottom ash would result in a mix of ash and sorbent which would be virtually indistinguishable from the ash currently generated. Alcoa currently has a permit to dispose of their ash. Based upon a "similar chemical

and physical composition" phrase in the Indiana Rules [329 IAC 2-9-3(b)(1)], it is likely that disposal of the ash/sorbent mixture would be allowed in the ash ponds. While unlikely, rules for "special wastes" including pollution control waste [329 IAC 2-21-1(a)(4)] may apply and may preclude sorbent disposal in the ash ponds. Proper notification and verification of solid waste rule applicability with Indiana Department of Environmental Management - Solid Waste Management Board will be completed prior to operation of the NDP.

5.3.2 Sulfur Recovery Unit Wastes

Wastes generated from the SRU will include the spent sulfur converter catalyst (non-hazardous) and the spent hydrogenation catalyst and fouled heat transfer fluid (hazardous). The hazardous wastes will be returned to the vendor for reclamation (Section 4.3.1.3). All wastes will be handled in accordance with applicable state and federal regulations.

5.4 Water Quality

5.4.1 Surface Wastewater Discharge

Under the provisions of the federal Clean Water Act and the Indiana Industrial Wastewater Pretreatment Regulations, the Indiana Department of Environmental Management - Water Pollution Control Board administers a program to monitor and treat industrial and municipal discharges to the waters of the United States. The agency, through issuance of permits, specifies the terms and conditions under which WPP may discharge wastewater. WPP currently operates under Permit No. IN0001155. The demonstration project activities will likely not require modifications to the existing NPDES permit; however, the IDEM will be notified prior to the operation of the NDP about the minor increases in wastewater discharge (Section 4.4.1).

Federal stormwater regulations adopted in 1990 require that stormwater discharges associated with industrial activities be permitted. Stormwaters at the WPP are already identified in the NPDES permit. New paved areas in the facility will be routed to existing drains, therefore a new permit will not be required. Construction projects disturbing more than five acres of land also require permitting. The NDP project will only disturb one to two acres maximum during construction.

5.5 Ecology

Under the Endangered Species Act of 1973, DOE must consult with the U.S. Fish and Wildlife Service to ensure that proposed actions are not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of the critical habitat of such species (Section 3.4.3).

5.6 Miscellaneous

5.6.1 Building Permits

A "Construction Release" will be obtained from the State Building Commissioner. After receipt of the Construction Release, a "Warrick County Improvement Location Permit" will be obtained from the office of the Warrick County Area Planning Commission. If applicable, upon receipt of this permit a local "Warrick County Building Permit" can then be obtained from the Warrick County Commissioners' Office. Finally, a "Statement of Substantial Completion - Request For Inspection" will be submitted to the State Building Commissioner.

5.6.2 FAA

The FAA requires submittal of a Notice of Proposed Construction or Alteration for projects where the height exceeds 200 feet. Because the tallest NDP structure will be about 150 feet, no FAA notification would be required.

5.6.3 Health and Safety

The Emergency Planning and Community Right-to Know Act of 1986 (EPCRA) established government and industry requirements for emergency planning and community reporting on hazardous chemicals. EPCRA provisions include emergency planning, emergency notification, community right-to-know reporting requirements, and toxic chemical release and emissions inventory reporting requirements. The objective of these reporting requirements is to help the state and local communities become informed of chemical hazards in the overall community as well as at individual industrial sites.

The NDP would produce H_2S and SO_2 as intermediate by-products of sorbent regeneration. These compounds are listed as an extremely hazardous substances under EPCRA. The threshold planning quantity (TPQ) amount of material stored on-site which triggers inventory reporting requirements is 500 pounds for both H_2S and SO_2 . An accidental release, in excess of the reportable quantity (RQ), into the environment would require immediate notification to the state and local emergency response commissions. The RQ for H_2S is 100 pounds, while the RQ for SO_2 is 1 pound. At no time will NDP H_2S and SO_2 quantities exceed the TPQ; therefore, no reporting or planning will be required for these compounds under EPCRA.

Potential workforce health and safety issues of the NDP would also be regulated by the Occupational Safety and Health Act (OSHA). All applicable regulations will be followed. Specific health and safety issues are discussed in Sections 4.6.1.1 and 4.6.1.2. In addition to general OSHA regulations, a process safety management plan would be required when highly hazardous substances exceed specified limits. For the NDP, H_2S and SO_2 levels will fall under the OSHA threshold quantities of 1500 pounds for H_2S and 1000 pounds for SO_2 .

Under the Clean Air Act, Part 68 - Chemical Accident Prevention Provisions, a risk management plan would be required for substances which exceed specified quantities. The NDP

will fall below the threshold values for H₂S and SO₂, 10,000 pounds and 5,000 pounds respectively.

5.6.4 Historic Preservation

In accordance with the provisions of Section 106 of the National Historic Preservation Act of 1966 (36 CFR 800), federal projects must be reviewed to determine their effect on historic properties. The DOE has been advised by the Indiana Division of Historic Preservation and Archaeology that the proposed project would have no impact on archaeological, architectural, or historical sites listed in or eligible for inclusion in the National Register of Historic Places.

6 OCP PROPOSED ACTION AND ALTERNATIVES

As discussed in Section 2.0, the purpose of the proposed action is to demonstrate the NOXSO flue-gas treatment system in a fully integrated commercial scale operation. The proposed action will reduce SO₂ and NO_x emissions from Alcoa Generating Corporation's Warrick Power Plant Unit 2. The removed sulfur will be processed into elemental liquid sulfur. In addition, as part of the project a liquid SO₂ plant will be constructed at Olin Chemicals' Charleston Tennessee facility to convert the sulfur into liquid SO₂.

This section, and the subsequent sections, discuss the liquid SO₂ plant portion of the proposed project. The following section presents information covering the project site and engineering description of the liquid SO₂ plant.

6.1 Site Description of the Proposed Action

The description of the Olin Charleston Plant (OCP) is presented in the following sub-sections. The first sub-section provides a brief description of the OCP. The second sub-section describes the general location of the Charleston plant. Sub-sections three and four review existing environmental considerations and resource requirements, respectively.

6.1.1 Existing Facility

The OCP is owned and operated by Olin Corporation, Figure 6-1 is a site plan of the OCP. There are five basic areas within the plant: administration, including process technology and product quality/environmental control buildings; chlor-alkali, consisting of chlorine/caustic soda production facilities, Reductone® (sodium hydrosulfite) production facilities, hydrochloric acid production facilities, boiler house, and water treatment; HTH® Dry Chlorinator (calcium hypochlorite) production facilities and associated warehousing; rubber services, and associated warehousing; and maintenance facilities.

6.1.2 General Location

As shown in Figure 6-2, the OCP is located in Bradley County, in southeastern Tennessee about 12 miles northeast of Cleveland, Tennessee. Charleston, Tennessee, the closest town to the site, is 1.5 miles southeast of the plant. The Charleston facility address is Post Office Box 248, Charleston, TN 37310.

The OCP consists of roughly 975 acres between Lower River Road and the Hiwassee River (which flows to the northwest), Figure 6-3. Tennessee Highway 11 crosses the river about 6000 feet upstream while Interstate 75 is less than two miles to the west. One other industrial site is nearby. Bowater Incorporated Southern Division (BISD) is located across the river and upstream about one mile. BISD is a newsprint and market pulp paper producer which receives caustic and chlorine from OCP.

Figure 6-1 OCP Site Plan

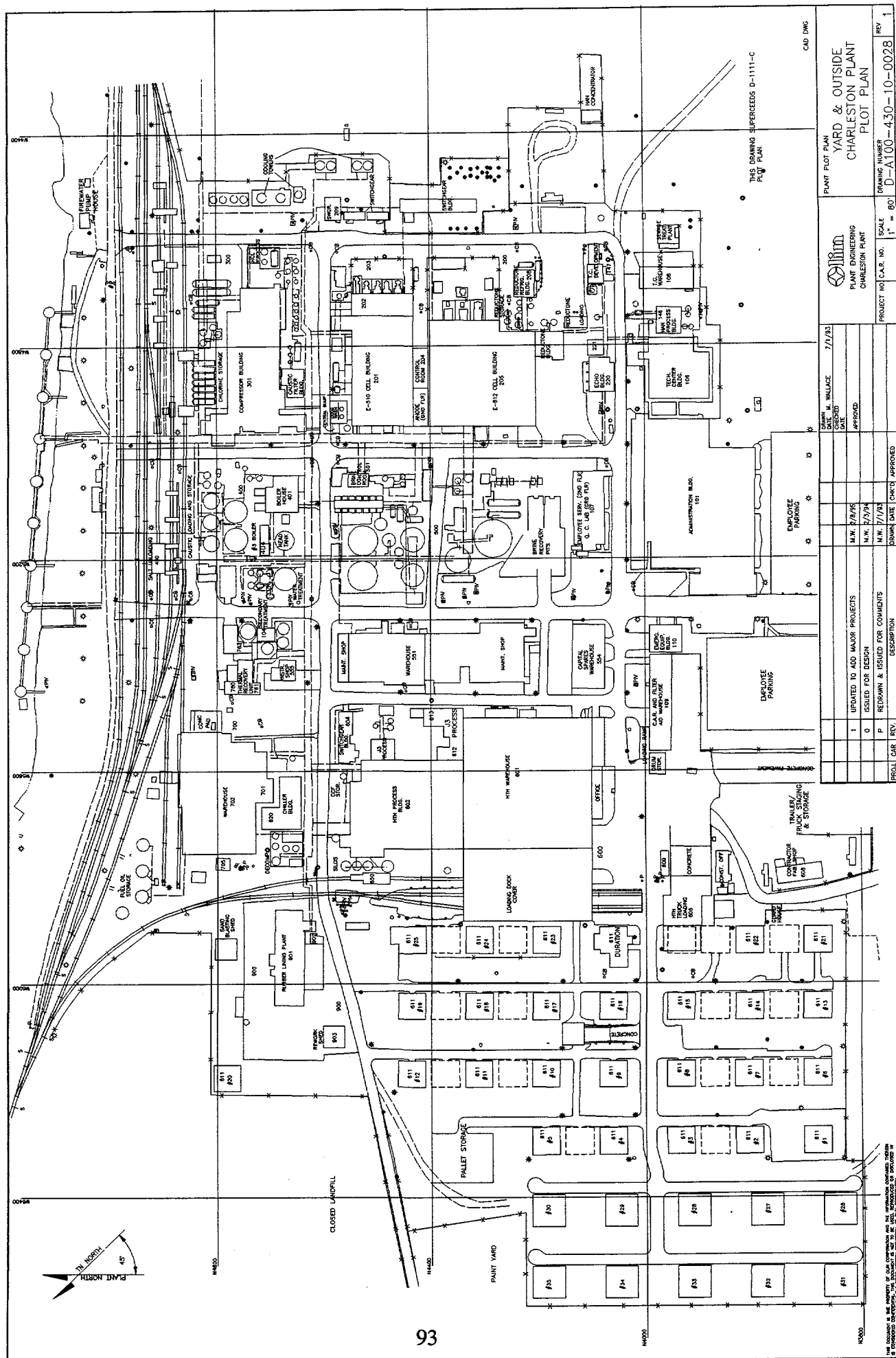


Figure 6-2 OCP Location

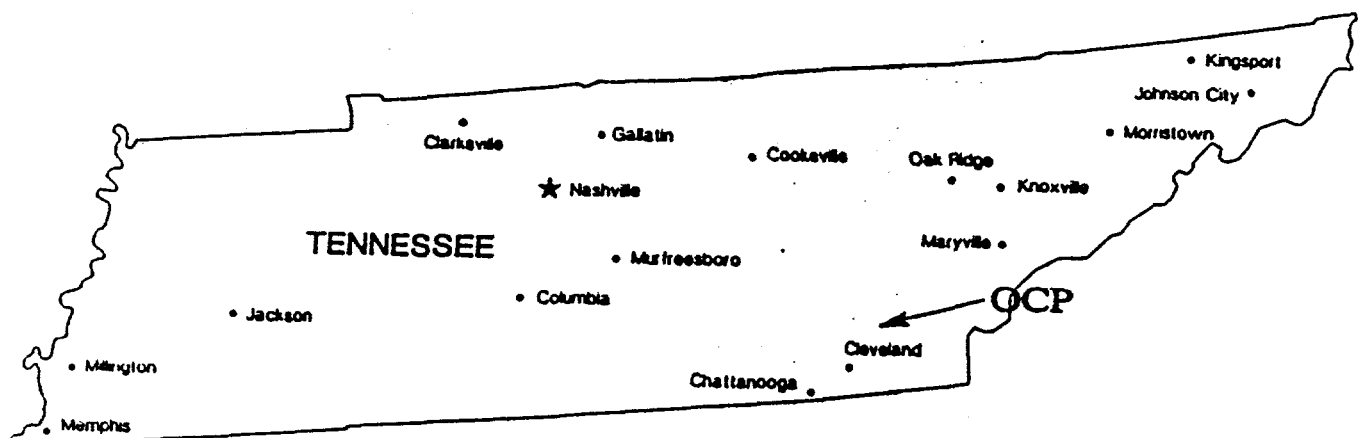


Figure 6-3 Closeup of OCP Location



The sparsely populated, rural area surrounding the plant lies within the Valley and Ridge Province, a repeating sequence of alternating ridges and valleys within the Cumberland, and Great Smoky Mountains.

6.1.3 Environmental Considerations

6.1.3.1 Existing Air Emissions

Available 1993 air emissions data for the OCP are as follows: < 5 tpy SO₂, 75 tpy NO_x, 21 tpy PM, <1 tpy CO, and <1 tpy VOC. These numbers are annual averages of values submitted on a Title V Emissions Verification Report to the Tennessee Air Pollution Control Board.

6.1.3.2 Water Use and Wastewater Discharge

This section discusses water use and waste water discharge associated with the OCP.

Water Use

Surface water used by the OCP is diverted from the Hiwassee River via intake pumps. River water is used primarily for once-through cooling purposes and as process water at the OCP. In 1993, the OCP diverted an average of 4.6 million gallons per day (mgd), all of which was returned to the Hiwassee River, excluding minor consumption and evaporative losses.

There is no groundwater usage at the OCP.

Wastewater Discharge

The OCP operates under a National Pollutant Discharge Elimination System (NPDES) permit (No. TN0002461) issued by the State of Tennessee Bureau of Environment, Division of Water Pollution Control. The four permitted outfalls associated with the OCP are outfalls 001, 002, 003, and 004 (Ref. 1). Table 6-1 describes the wastewater streams discharged through each outfall, the wastewater treatment method, and the average daily discharge flow.

Outfall 001 discharges process and domestic wastewater, rainfall runoff, car wash water, HAN pilot plant effluent, and landfill runoff. The outfall is monitored for flow, TSS, mercury, nickel, zinc, total dissolved solids, chlorine, pH, fecal coliform, and river flow.

Outfalls 002, 003, and 004 discharge once through cooling water and rainfall runoff to the Hiwassee River. These outfalls are monitored for chlorine, mercury, zinc, temperature, and pH.

Table 6-1 Description of Outfalls, Treatment, and Average Flows

Outfall No.	Outfall Description	Treatment	Average Flow (mgd)
001	Process outfall authorized to discharge treated process and domestic wastewater, rainfall runoff, car wash water, HAN pilot plant effluent, and landfill runoff.	cooling water blow down, molybdate treatment system; boiler blow down, phosphate treatment; process wastewater, settling, pH adjustment, and discharge.	0.72
002	Sewer outfall authorized to discharge once through cooling water and rainfall runoff.	None.	0.50
003	Sewer outfall authorized to discharge once through cooling water and rainfall runoff.	None.	2.12
004	Sewer outfall authorized to discharge once through cooling water and rainfall runoff.	None.	0.75

6.1.3.3 Solid Wastes

OCP is a large quantity generator, the OCP EPA waste disposal ID number is TND-00-333-7292. Ash from a mercury thermal recovery unit is disposed of in an on-site RCRA permitted hazardous waste landfill. OCP also generates brine sludge and chloride salts which are stored in two on-site Class II landfills.

6.1.3.4 Public Participation

The purpose of this section is to provide information for the DOE's public involvement in the DOE/NEPA process. The current draft plan is to announce in the local media that DOE is preparing a NEPA document for this project and invites all interested parties to contact DOE at a toll-free phone number. The interested parties will be able to leave recorded comments at this phone number. The DOE will respond to these comments and these comments will be taken into consideration in the NEPA documents.

The major newspapers in the area include the following:

- **Cleveland Daily Banner**
- **Chattanooga News-Free Press**
Telephone: (615) 756-6900
Circulation: Mon.-Fri.: 50,726, Sunday: 110,157

- **Chattanooga Times**
Telephone: (615) 756-1236
Circulation: Mon.-Fri.: 41,547

The major television and radio stations in the area include the following:

- **WCLE-1570 AM**
Telephone: (615) 472-6511
Format: Country
- **WGOW-1150 AM**
Telephone: (615) 756-6141
Format: News/Talk
- **WUSY-100.7 FM**
Telephone: (615) 892-3333
Format: Contemporary Country/News
- **WDEF-Ch12**
Affiliation: CBS
Telephone: (615) 267-3392
- **WDSI-Ch61**
Affiliation: Fox
Telephone: (615) 697-0661
- **WRCB-Ch3**
Affiliation: NBC
Telephone: (615) 267-5412
- **WTVC-Ch9**
Affiliation: ABC
Telephone: (615) 756-5500

6.1.3.5 Olin Corporate Environmental Responsibility

Olin Corporation and the OCP have shown a continued commitment to the environment through programs such as their voluntary participation in the EPA's "33/50" program and the Chemical Manufacturers Association's Responsible Care® program.

As a result of an extensive use of source reduction, recycling, treatment and other pollution prevention techniques, Olin Corporation reduced its total releases and waste transfers of EPA-reportable chemicals by 70% from 1987 through 1992. Olin also made continued progress in reducing emissions of the high-priority industrial compounds targeted under the EPA's "33/50" program. From the base year of 1988, through 1992, Olin has cut its releases and waste transfers of these compounds by 68%, far exceeding the EPA goal of a 50% reduction through 1995. Olin's environmental performance stems from annual pollution prevention goals established under its Responsible Care® initiative, which applies the principles of Total Quality Management in pursuing excellence in pollution prevention, workplace safety, emergency response, product stewardship, and community outreach.

An integral part of the OCP (an ISO 9002 Certified Plant), through the Responsible Care® initiative, is the community advisory panel, which assists in developing actions which are responsive to public concerns. Panel members represent a cross section of community leaders and residents of Charleston, in addition to several representatives of Olin. The panel is led by an independent facilitator. The Charleston community is encouraged to voice their questions or concerns through the citizens who serve on this advisory panel. The panel enables Olin to hear and respond to what local citizens think about issues related to the facility, and it helps citizens understand Olin and industry issues and to better evaluate them in relation to personal concerns. The panel accomplishes this by providing an opportunity for open dialogue between the community and the facility about future projects.

6.1.4 Resource Requirements

OCP resource requirements are summarized in Table 6-2 and discussed below.

Table 6-2 Olin Charleston Plant Resource Requirements

	Units	OCP
Liquid SO ₂	tpy	20,000
Electrical Power	MWh/y	1.1 * 10 ⁶
Fuel Oil	gpy	230,000
Labor	# of employees	625
Land	acres	975
Water	mgd	4.6

6.1.4.1 Chemical Feed Stocks

OCP uses liquid SO₂, mercury, HCl, H₂SO₄, and salt as chemical feed stocks. Annual consumption of liquid SO₂ is about 20,000 tons.

6.1.4.2 Electrical Power

Annual OCP power consumption is about 1.1 * 10⁶ MWh/y.

6.1.4.3 Fuel Oil

Annual OCP fuel oil consumption is about 230,000 gallons. The fuel oil is used in boilers to generate high pressure process steam.

6.1.4.4 Labor

OCP is staffed by about 625 employees.

6.1.4.5 Land

The OCP consists of about 975 acres of which about 375 acres are developed.

6.1.4.6 Water

The annual surface water usage for the OCP is about 4.6 mgd, ground water is not used on site.

6.2 Engineering Description

The following section presents a summary of the liquid SO₂ plant. Subsequent sections detail the unit operations of which the plant is comprised, the major phases and schedule, installation and construction activities, project resource requirements, and potential Environmental Health, Safety and Socioeconomic (EHSS) effects on the work force and general public.

6.2.1 Liquid SO₂ Plant

The liquid SO₂ plant consists of two components, the Calabrian Liquid SO₂ Process and a cryogenic air separation unit (ASU). The plant will be located on less than an acre of Olin property east of the existing switchgear building. The previously disturbed, grass covered area has been filled with local soils to a level above the 100 year flood plain. Figure 6-4 presents the site plan for the liquid SO₂ plant, detailing its relationship within Olin's plant site.

The Calabrian Liquid SO₂ Process, the primary aspect of the liquid SO₂ plant, is an advanced liquid SO₂ production process designed for ease of operation and maintenance and to minimize process waste streams and emissions to the environment. In the basic process, molten sulfur is oxidized to SO₂ vapor, the SO₂ vapor is then separated from vaporized sulfur and condensed. Key resources, including molten sulfur, oxygen (O₂), and caustic, are fed to the process. The process in turn produces liquid SO₂, steam, and sodium sulfite.

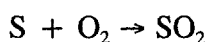
The second component, the cryogenic air separation unit, provides essentially pure O₂ to the liquid SO₂ process. The oxygen is produced by liquefying air and then using fractional distillation to separate it into its components. The air separation unit requires inputs of air and cooling water and produces, in addition to the O₂, a small amount of pure nitrogen (N₂). Millions of tons per year of pure O₂ is produced world-wide using cryogenic air separation units.

6.2.1.1 Liquid SO₂ Process

Process Description

The process will have the operating capacity to produce about 125 tpd (45,000 tpy) of liquid SO₂. Figure 6-5 presents a basic flow diagram of the Calabrian Liquid SO₂ Process. Primary unit operations are numerically labelled on this figure and referenced in the following discussion. Liquid sulfur at about 270°F is continuously pumped from a 250 ton capacity molten sulfur storage tank (Unit 1) to the molten sulfur day tank (Unit 2). From the day tank sulfur flows by gravity to the SO₂ reactor (Unit 3). The sulfur level in the reactor is controlled by equalization with the level in the molten sulfur day tank.

During start up the molten sulfur in the reactor is electrically heated to about 600°F. Oxygen is then injected into the molten sulfur through a submerged sparger. The oxygen will be separated from air in a cryogenic air separation plant described later (Section 6.2.1.2). The molten sulfur at the reactor operating pressure, about 80 psig and 600°F is above the auto-ignition temperature. The following reaction occurs:



The reaction is spontaneous and exothermic. The reactor temperature rises to about 1100°F, the boiling point of sulfur at 80 psig. The production rate of SO₂ is controlled by the oxygen feed rate to the reactor.

The vapor stream of SO₂ and sulfur is cooled in the sulfur condenser (Unit 4) to about 270°F. The condenser is cooled by generating steam at about 25 psig. Most of the sulfur vapor condenses and the mixture of condensed sulfur, which flows by gravity, and SO₂ vapor is returned to the molten sulfur day tank. The liquid sulfur drops out in the sulfur day tank and is recycled to the reactor.

The SO₂ vapor does not condense at 270°F and is not significantly soluble in molten sulfur. It is further cooled in the twin condensers (Units 5 A & B) to remove additional trace amounts of sulfur. The condensers operate in a two step repeating cycle. In the first step, the condenser cools the SO₂ to 120°F using cooling water. Entrained liquid sulfur and remaining sulfur vapor will collect as a solid on the condenser tube walls. In the second step, the condenser gas outlet is blocked and the sulfur is melted using low pressure steam. The molten sulfur will drain by gravity back to the sulfur day tank. The condensers will alternate between these modes of operation, one condenser will remove sulfur while the second condenser is regenerated using steam.

After filtration (Unit 6) the SO₂ vapor is condensed in the SO₂ condenser (Unit 7) using cooling water. At the system pressure of 80 psig the SO₂ condenses at about 104°F. The liquid SO₂ will flow to the liquid SO₂ surge tank (Unit 8). From the surge tank it will be pumped through a filter (Unit 9), to remove any entrained particulate, to a 150 ton capacity liquid SO₂ storage

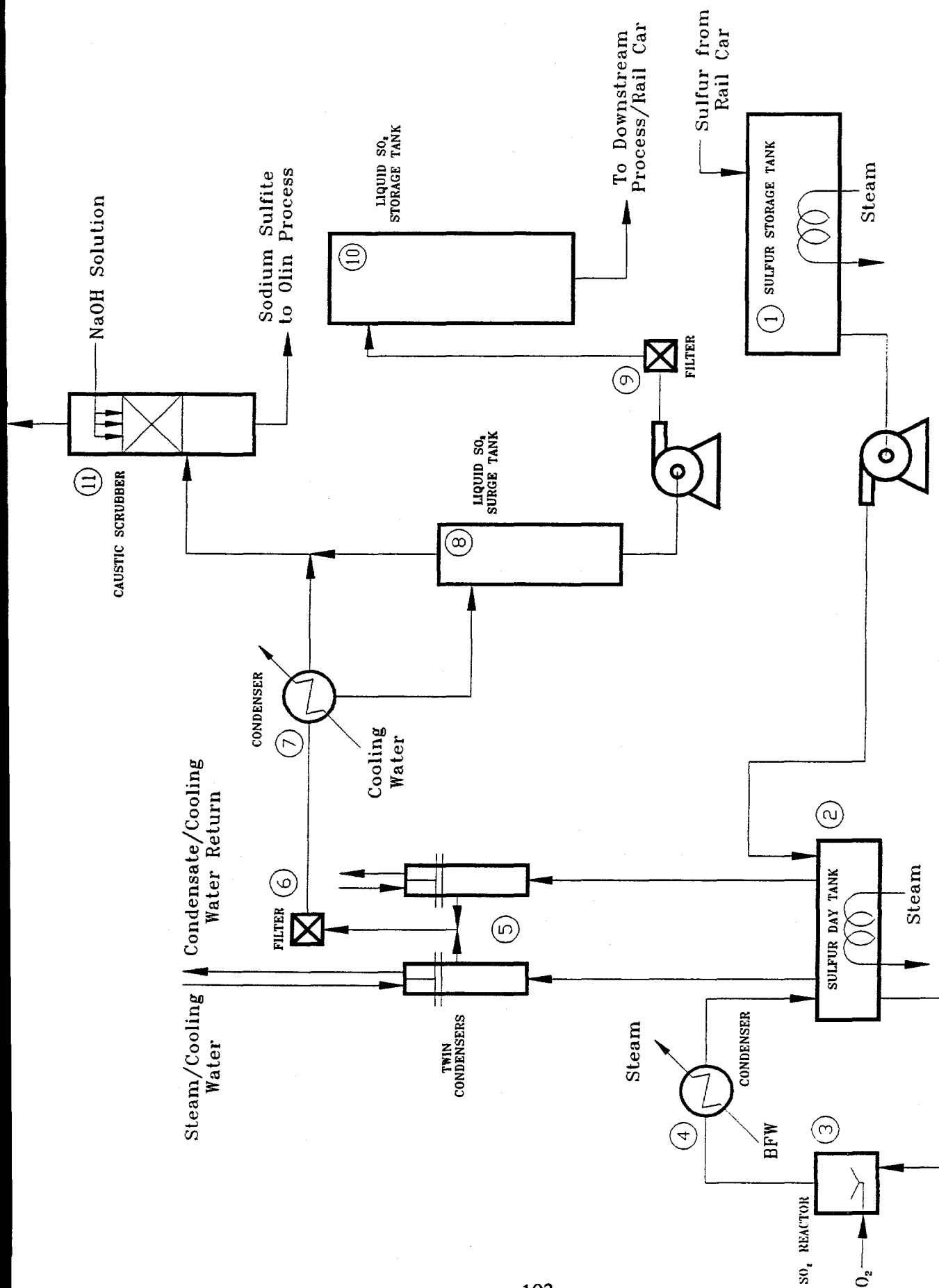


Figure 6-5 Calabrian Liquid Sulfur Dioxide Process

tank (Unit 10). From the storage tank the liquid SO₂ will be pumped to an existing process liquid SO₂ feed tank or to rail cars for shipment.

A vent stream from the SO₂ condenser and liquid SO₂ surge tank contains non-condensibles, trace amounts of nitrogen and argon introduced to the sulfur reactor with the oxygen, and SO₂ vapor. The SO₂ vapor is removed from the vent stream in a caustic scrubber (Unit 11). A sodium hydroxide (NaOH) solution is used to remove the SO₂ vapor from the gas stream. The sodium sulfite formed from the reaction of NaOH and SO₂ will be used by Olin to neutralize a chlorine waste stream from an existing Olin process.

The cooling water required by the Calabrian Liquid SO₂ Process will be supplied from existing on-site cooling towers.

Process Alternatives/Advantages

Traditional, older processes used to produce liquid SO₂ from sulfur involve burning the sulfur in air. The resulting gas stream can contain, at best, 16 - 18 vol. % SO₂ with the balance being mainly nitrogen, oxygen, and water from the combustion air. The SO₂ must then be separated from the other combustion gases. This is done by stripping the SO₂ from the gas stream using either water or an organic solvent like dimethylaniline. Regardless of which stripping liquor is used, these processes are more complex and have greater environmental impacts. To illustrate, the burn in air with water stripping process is described below.

In the burn in air process, molten sulfur is pumped to the sulfur burner where it is atomized prior to combustion using compressed air. As discussed above, the process gas will contain about 16-18% SO₂. The approximately 2500°F combustion gases are cooled in a downstream waste heat boiler which produces 600 psig steam. After the waste heat boiler, the process gas is further cooled in a series of two water spray cooling towers. These cooling towers generate an acidic wastewater stream which must be neutralized. The gas exiting the second cooling tower passes to a compressor where the pressure necessary to move the process gas through the rest of the process is developed.

The remainder of the system involves stripping the SO₂ from the process gas stream with water and then recovering the SO₂ adsorbed in the water. From the compressor, the process gas stream flows through two adsorption towers in series where the SO₂ in the process gas is adsorbed into water. A vent stream from the second tower must be scrubbed prior to venting to remove residual SO₂.

The water containing the adsorbed SO₂ is heated in a series of heat exchangers and passes to the stripping tower. In the stripping tower, steam is used to heat the SO₂ rich liquor to liberate the SO₂. The concentrated SO₂ stream generated contains water and must be dried. A condensing tower using cold water removes most of the water. The remaining water is removed using a series of packed spray towers using 93% sulfuric acid as the desiccant. The spent acid formed must be sent to an acid reclamation unit or a licensed disposal facility. The pure SO₂ stream from the third drying tower is compressed to about 80 psig and passes to a condenser. Cooling

water is used in the condenser, and liquid SO₂ is accumulated in a collector tank before being pumped to storage.

The organic solvent based processes are essentially identical to the water adsorption process described above. However, solvent emissions and the disposal of spent solvent adds an additional area of concern.

Process advantages of the Calabrian Process include the following:

- Process gas at a lower temperature, 1100°F versus about 2500°F.
- Production of lower pressure steam, 25 psig versus 600 psig.
- No acidic wastewater stream which must be neutralized.
- Smaller volume tail gas stream which economically allows for the use of a more efficient scrubber resulting in lower SO₂ emissions.
- No spent acid stream which must be reclaimed or disposed of.
- No solvent emissions or disposal of solvent.

In addition, due to the lower process gas temperature and steam pressure, and simplicity of the process the Calabrian Process is inherently more reliable and safe to operate.

6.2.1.2 Air Separation Unit

Figure 6-6 presents a basic flow diagram of the air separation unit used to supply O₂ to the liquid SO₂ process. Primary unit operations are numerically labelled on this figure and referenced in the following discussion.

As mentioned previously, oxygen is produced by liquefying air and then using fractional distillation to separate the liquefied air into its components. The three fundamental steps in this process are purification, refrigeration, and rectification.

Purification

Atmospheric air contains dirt, water vapor and carbon dioxide (CO₂) which must be removed from the compressed air stream to prevent plugging of downstream process equipment. The atmospheric air passes through an intake filter (Unit 1) to remove entrained particulate and is compressed to 125 psig in a centrifugal compressor (Unit 2). After compression the air is cooled in an after cooler (Unit 3) using cooling water and the condensed water is removed in a high efficiency moisture separator (Unit 4). An integral 500 gpm cooling tower provides the cooling water for the ASU. Carbon dioxide and additional water vapor is then removed by adsorption on a molecular sieve (Unit 5). Two molecular sieve units are used, like the twin condensers from the liquid SO₂ process, one sieve will be regenerated while the other is online. The molecular sieves are regenerated using heat and a nitrogen purge gas generated downstream.

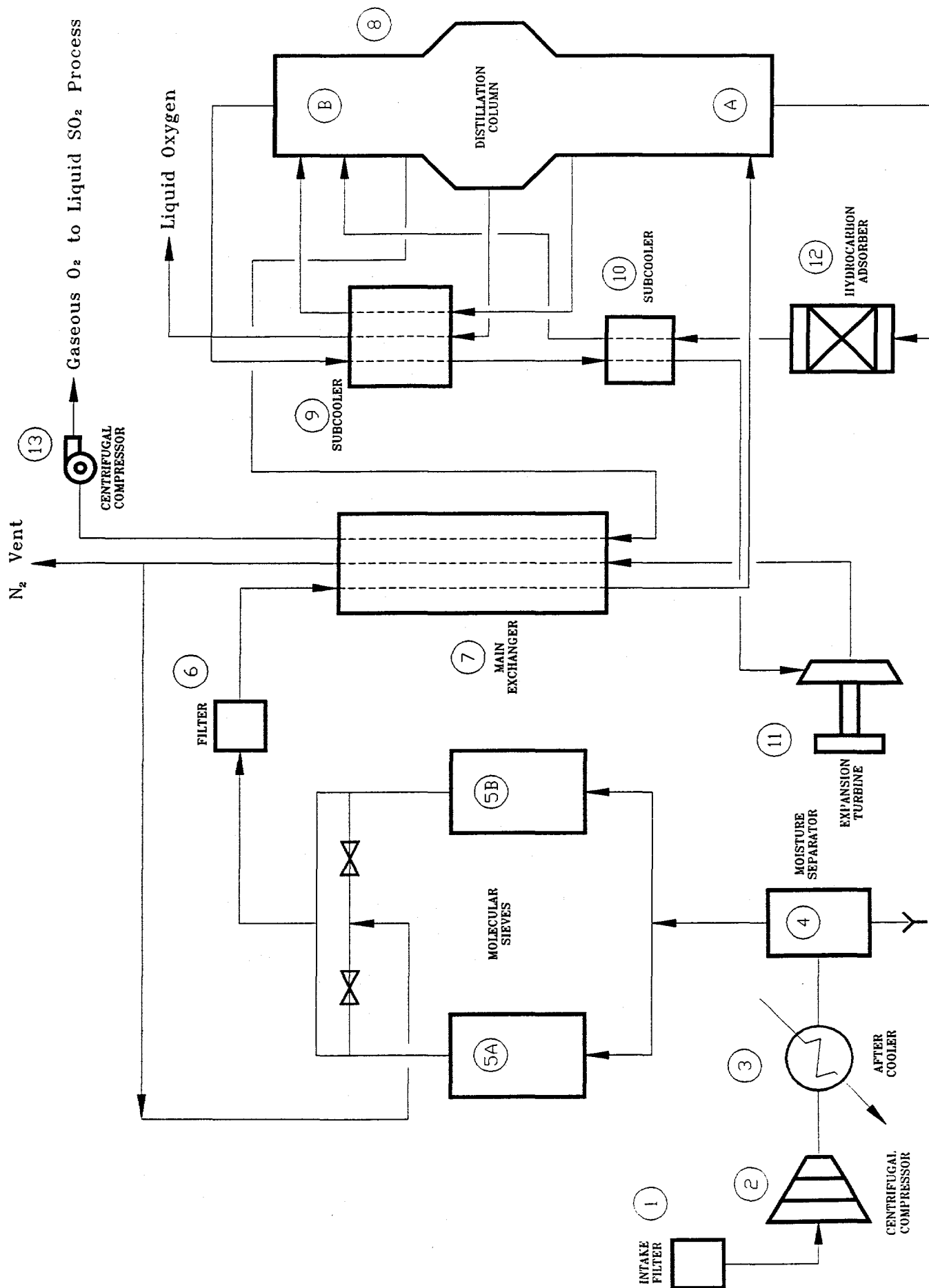


Figure 6-6 Air Separation Unit

Refrigeration/Rectification

The purified air passes through a pipeline filter (Unit 6) and enters the main exchanger (Unit 7) where it is cooled by heat exchange with outgoing gaseous oxygen and waste gas. After the main exchanger, the purified air enters the bottom section of the lower column (Unit 8A) of the distillation column (Unit 8). The lower column operates at about 125 psig while the upper column (Unit 8B) of the distillation column operates at about 30 psig. Rectification, vapor - liquid contacting, occurs in the distillation column. As the incoming air rises up the column it contacts a descending liquid. Since oxygen has a higher boiling point than nitrogen as the vapor ascends it becomes richer in nitrogen while as the liquid descends it becomes richer in oxygen. Cold nitrogen rich vapor is withdrawn from several places within the distillation column and used to cool recycle streams in the subcoolers (Units 9 & 10). Heat energy is also removed from the system by expanding the nitrogen rich vapor in the expansion turbine (Unit 11), thereby doing work and lowering the temperature. Silica gel is used to remove hydrocarbons from the oxygen rich liquid in the hydrocarbon adsorber (Unit 12). Pure oxygen vapor is withdrawn from the bottom of the upper column. This vapor is warmed in the main exchanger and compressed using a centrifugal compressor (Unit 13) to the required operating pressure.

6.2.2 Project Phases

The liquid SO₂ plant will be completed in the same three primary phases as the NOXSO Process and SRU at Warrick Indiana. The following discussion summarizes these phases and a project milestone scheduling chart is shown in Figure 6-7.

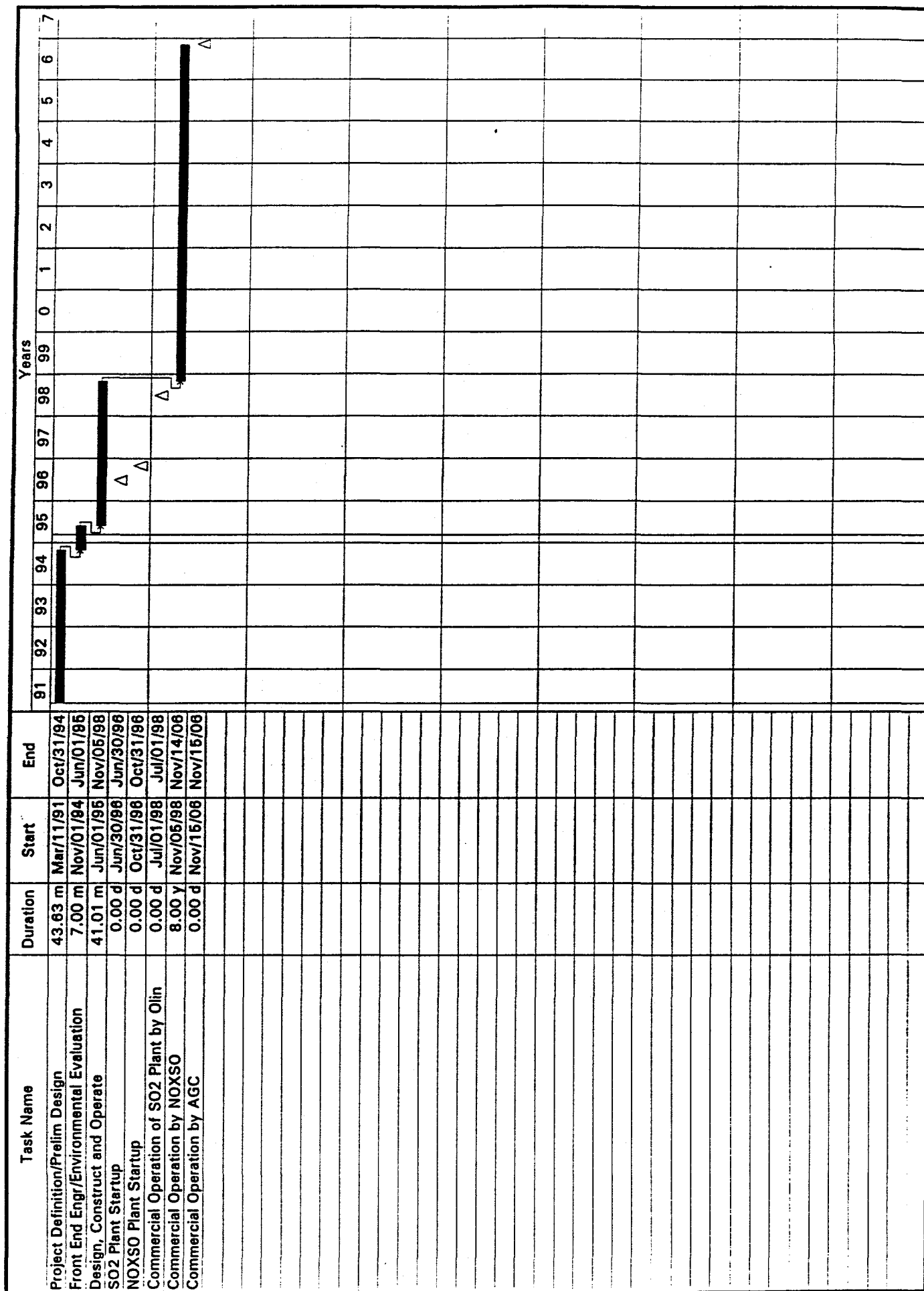
6.2.2.1 Phase 1A - Project Definition/Preliminary Design

Preliminary process flow diagrams, piping and instrumentation diagrams, major equipment specifications, plant layout drawings, cost estimates, project schedules, and the Project Management Plan were prepared in this phase. In addition, other preliminary design work such as engineering optimization studies, site survey, and geotechnical investigation and host site characterization are included. Phase 1A was completed in November 1994, however DOE approval to proceed to Phase 1B was not granted until January 1995.

6.2.2.2 Engineering/Environmental Evaluation

The front end engineering and environmental evaluation phase includes finalization of all design considerations and preparation of the Environmental Information Volume (EIV) in compliance with NEPA. Engineering drawings will be prepared for the civil/structural design, mechanical design, electrical design, and instrumentation and control systems design. Bid packages will also be prepared and distributed in preparation of awarding construction services. This phase will run about 7 months.

Figure 6-7. Project Milestone Scheduling Chart



6.2.2.3 Phase 2 - Design, Construct, Operate

Design and construction includes all activities necessary for detailed design and erection of the liquid SO₂ plant, including a process hazard evaluation/safety review and a system shakedown test. Detailed design includes final preparation of all engineering drawings and equipment specifications necessary to procure all materials of construction. The process hazard evaluation/safety review will include the following: design system review, electrical classification review, safety department audit, and a "what if" procedure. Shakedown activities include inspections, tests, and calibrations that are required to ensure that all components are properly installed, prepared, and fully functional at start-up.

A plant start-up plan to ensure that the start-up is organized and operational status is achieved in the minimum time and with maximum safety will also be prepared. This plan will identify and determine the sequence of steps for facility start-up and will present the essential information and procedures required by operation personnel for normal start-up, continuous operation, shutdown, and emergency procedures. Design, construction and start-up will be completed by July 1, 1996.

A two-year test and demonstration of the liquid SO₂ plant will be followed by commercial operation. During the two-year test demonstration period the purity of sulfur produced by the NDP and the production of liquid SO₂ will be verified. Following the demonstration period, the plant will be leased for eight years to Olin for commercial operation. At the end of the eight year lease, ownership of the plant will revert to Olin and it will be operated indefinitely.

6.2.3 Project Source Terms

Those components of the project which may be determined to have an impact on the environment are referred to as project source terms. The project source terms for the liquid SO₂ plant include; air emissions, aqueous wastewaters, solid waste and noise, and are addressed as they relate to both the construction and operation phases. Impacts associated with these environmental considerations are discussed in Section 8.

6.2.4 Potential Environmental, Health, Safety and Socioeconomic Receptors

A number of environmental features could potentially be affected by the proposed action. These include air quality, ground water quality, land use, labor force, and energy resources. Section 7 focuses on characterizing the existing environment with respect to these probable receptors. Section 8 evaluates the probable impact of the proposed project on these receptors.

6.2.5 Project Resource Requirements

The liquid SO₂ plant energy and material resource requirements are discussed in the following sub-sections and summarized in Table 6-3. The resource requirements shown are based on the maximum plant operating capacity of 45,000 tpy, resource requirements may decrease depending on the actual plant capacity factor.

Table 6-3 Liquid SO₂ Plant Resource Requirements

RESOURCE	UNITS	NDP
Caustic	tpy	5,712
Electricity	MWh/yr	9,636
Fuel Oil	gpy	0
Labor		
Construction	# Persons	20
Operation	# Persons	4
Land	acres	< 1
Oxygen	tpy	22,950
Sulfur	tpy	23,130
Water	mgd	0.03

6.2.5.1 Caustic

About 5,712 tpy of 20 wt. % caustic solution will be consumed by the liquid SO₂ plant.

6.2.5.2 Electric Power

The net electrical consumption is about 1,100 kW, 9,636 MWh/y.

6.2.5.3 Fuel Oil

No additional fuel oil will be required for the operation of the liquid SO₂ process or the ASU.

6.2.5.4 Labor

An estimated 20 construction, supervision, and labor personnel will be required during construction.

The liquid SO₂ plant will be integrated into the operations of the existing facility; it is anticipated that 1 additional operations personnel will be required per shift. Assuming 3 shifts per day and a relief shift, 4 additional operations personnel will be required.

6.2.5.5 Land

The liquid SO₂ plant will occupy less than an acre of unutilized land within the Olin facility.

6.2.5.6 Oxygen

The liquid SO₂ process will consume about 22,950 tpy of oxygen. The oxygen will be separated from the atmosphere by the ASU.

6.2.5.7 Sulfur

The liquid SO₂ plant will consume about 23,130 tpy of sulfur. About 16,060 tpy will be supplied by the NOXSO Demonstration Project at Warrick, the additional sulfur will be purchased from the open market.

6.2.5.8 Water

The liquid SO₂ process and ASU will use about 0.03 mgd of surface water for various process operations.

6.3 Alternatives

6.3.1 Alternatives Eliminated from Consideration

The alternatives are the same as those presented in Section 2.3.1.

6.3.2 No-Action Alternative

The no-action alternative is the same as presented in Section 2.3.2.

6.4 References

6.4.1 Cited

1. State of Tennessee Bureau of Environment, Division of Water NPDES Application. Permit No. TN 0002461

6.4.2 Uncited

1. Olin Corporation
2. Calabrian Corporation

7 OCP EXISTING ENVIRONMENT

This section describes the existing environment within and around Olin Corporation's Charleston, TN facility. Equipment related to the liquid SO₂ plant will be installed within this industrial facility. A detailed description of the project site location, the atmospheric, land and water resources, the ecological conditions, and the socioeconomic, aesthetic, and cultural resources is provided.

7.1 Atmospheric Resources

7.1.1 Site Meteorology

Site meteorology is based on local climatological data for Chattanooga, TN. While Chattanooga lies 25 miles southwest of the project site, both locations lie between the Cumberland and Great Smoky Mountains in the Valley and Ridge Province.

Chattanooga has a moderate climate, characterized by cool winters and quite warm summers. The Cumberland Mountains, to the west, have a moderating influence on the local climate by retarding the flow of cold air from the north and west. Annual temperature and precipitation data for the Chattanooga area are presented in Table 7-1 (Ref.1). The average monthly temperature ranges from 40.9°F (January) to 78.9°F (July), with a mean annual temperature of 60.3°F. The mean annual precipitation is 52.2 in. The average annual snowfall is 4.4 in; however, snowfall from year to year is highly variable with some winters having little or none. Clear days (30% cloud cover or less) occur an average of 29% of the year, while cloudy days (80% or more cloud cover) occur an average of 42% of the year. These data represent averages from 1930 to 1993.

Figure 7-1 presents a wind rose for the Chattanooga area. Meteorological data used to generate the wind rose are surface data recorded by the National Weather Service at Chattanooga, Tennessee from 1984 to 1992.

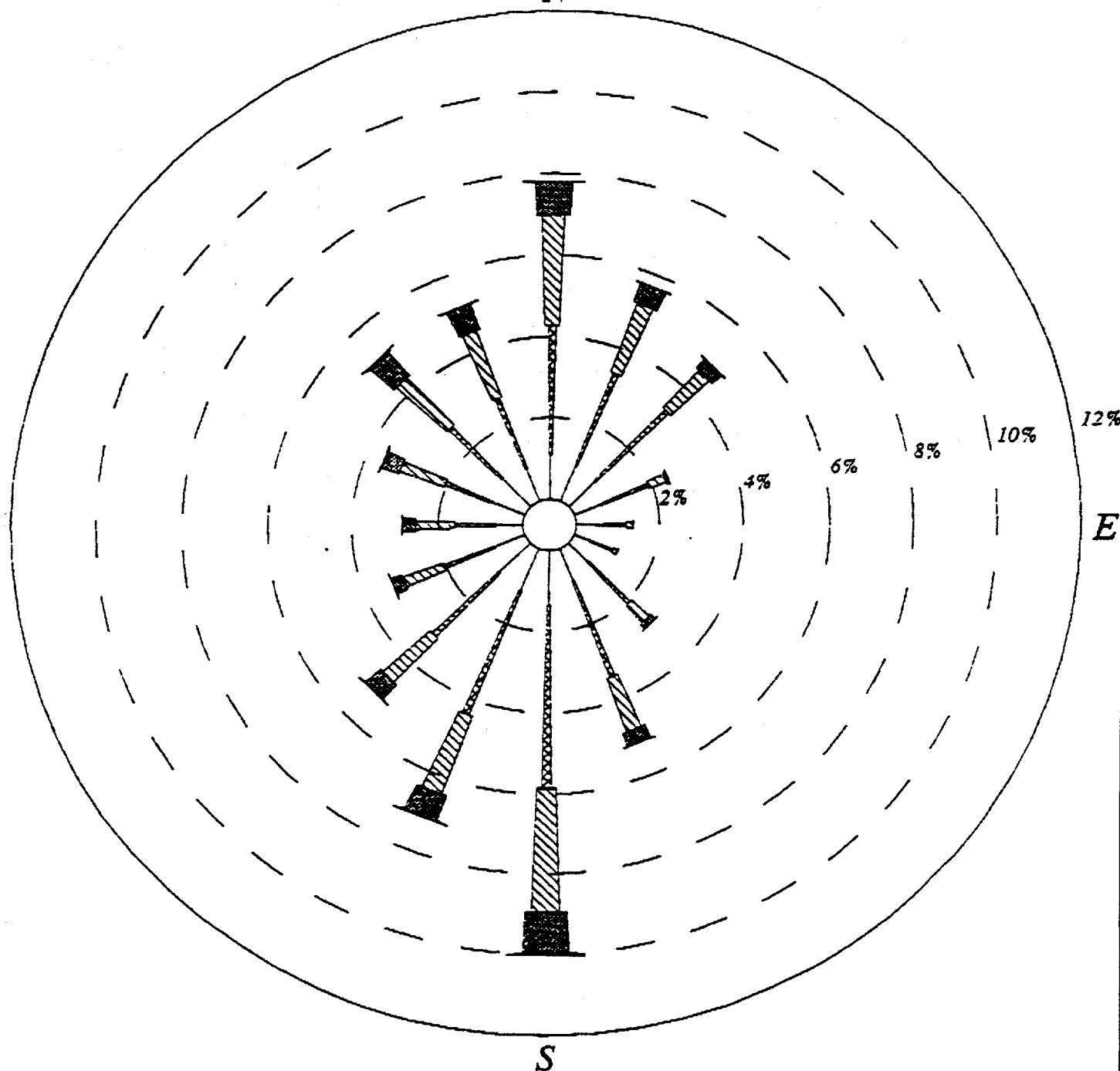
Morning fog is common in the Charleston, Hiwassee River area. Fog is defined as a cloud with its base at or very near the ground. Physically, there is basically no difference between a fog and a cloud; the appearance and structure are the same. While clouds result when air rises and cools adiabatically, fogs (with the exception of upslope fogs) are the consequence of radiation cooling or the movement of air over a cold surface. In other circumstances fogs are formed when enough water vapor is added to the air to bring about saturation. The primary source of atmospheric water vapor in the area is evaporative losses from the Hiwassee River. The lower portion of the Hiwassee River is impounded and forms an embayment which extends past Hiwassee River Mile (HiRM) 20. OCP is located at HiRM 17.5. The embayment has a water surface area of approximately 10 square miles.

Table 7-1 Average Chattanooga, TN Temperature and Precipitation Data

Average Chattanooga, TN, Temperature and Precipitation Data (1930 - 1993)				
Month	Average Daily Temperature (°F)			Average Precipitation (inches)
	Max	Min	Mean	
January	49.7	32.1	40.9	5.16
February	53.2	33.9	43.6	4.98
March	61.5	40.8	51.2	5.89
April	71.4	49.0	60.2	4.55
May	79.5	57.1	68.3	3.98
June	86.4	65.3	75.9	3.91
July	88.8	68.9	78.9	4.62
August	87.9	68.0	78.0	3.72
September	82.9	62.2	72.6	3.42
October	72.5	49.9	61.2	3.03
November	60.5	39.8	50.2	3.88
December	51.4	33.6	42.5	5.11
Year	70.5	50.0	60.3	52.24

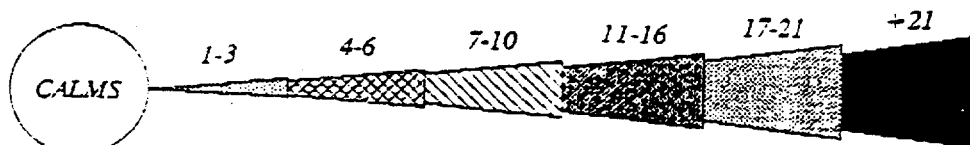
Chattanooga, TN

N



WIND SPEED (KNOTS)

NOTE: Frequencies indicate direction from which the wind is blowing.



7.1.2 Air Quality

The Tennessee Department of Environment and Conservation (TDEC), Air Pollution Control Division, tracks air quality by county. The OCP is in a region (Bradley County) that attains National Ambient Air Quality Standards (NAAQS) for SO₂, NO_x, PM₁₀, CO, O₃, and TSP. An attainment classification has not been made for lead (Pb). Across the Hiwassee River, McMinn County has the same NAAQS attainment classifications as Bradley County. Polk County, to the east-southeast of Bradley County is in nonattainment for SO₂. NAAQS designations for Bradley County and four surrounding counties are shown in Table 7-2. Summaries of maximum concentrations of NAAQS pollutants are shown in Table 7-3.

7.2 Land Resources

7.2.1 Topography

The OCP lies in the White Oak Mountains, between the Cumberland Mountains to the west and the Great Smoky Mountains to the east. There is a major low-angle fault where the Great Smoky Mountains moved northwest over the thrust plane. Local topography is complex with a number of minor valleys and ridges giving a local relief of as much as 500 ft. The site area is bordered on the south by Lower River Road, on the north by the Hiwassee River, and on the east and west by topographically lower inlets of the river. The highest existing elevation in the area is about 762 feet above mean sea level (MSL) and the lowest existing elevation is about 688 feet MSL at the Hiwassee River.

The northern and eastern undeveloped portions of the OCP site area are relatively flat and lie within the floodplain of the Hiwassee River. The developed portion of the OCP, including the proposed project site, has been backfilled above the 100-year flood plain. Along the west side of the site area is a ridge which extends from Lower River Road to the north. Lateral slopes off of the ridge are approximately 10% on the eastern side and 20% on the western side. The western side of the ridge supports a moderate to thick stand of mixed pines and hardwood trees. The eastern side of the ridge has been cleared during past borrow operations with the vegetation limited to grasses and a few small shrubs. Extensive erosion and gullying has occurred in the bare areas.

7.2.2 Geography

The OCP lies within the Valley and Ridge Province, a repeating sequence of alternating ridges and valleys. The subsurface conditions can be generalized as residual soils formed by the in-place weathering of the underlying limestone and shales of the Nolichucky Formation. The rock formations outcrop in northeast-southwest trending belts. The site is underlain by the Cambrian-aged Conasauga Shale. In some locations the shale is interbedded with siltstone. Bedrock formations have been closely folded and faulted. The shale has been so deformed by folding that fractures form an interconnected network; groundwater moves through this network of fractures. This formation does not form very deep soils.

Table 7-2 Air Quality Designations

Pollutant	Bradley County Tennessee	McMinn County Tennessee	Meigs County Tennessee	Hamilton County Tennessee	Polk County Tennessee
SO ₂	attainment	attainment	attainment	attainment	does not meet primary or secondary standards
NO ₂	attainment	attainment	attainment	attainment	attainment
PM ₁₀	attainment	attainment	attainment	attainment	attainment
CO	unclassifiable/ attainment	unclassifiable/ attainment	unclassifiable/ attainment	unclassifiable/ attainment	unclassifiable/ attainment
O ₃	unclassifiable/ attainment	unclassifiable/ attainment	unclassifiable/ attainment	unclassifiable/ attainment	unclassifiable/ attainment
Pb	not designated	not designated	not designated	not designated	not designated
TSP	attainment	attainment	attainment	attainment	attainment

Source 40 CFR 81 (confirmed with Tennessee Department of Environment and Conservation Air Pollution Control Division).

Notes:

- Designation definitions (from Clean Air Act Section 107(d)(1)(A)(i-iii)).

nonattainment: Any area that does not meet (or that contributes to ambient air quality in a nearby area that does not meet) the national primary or secondary ambient air quality standard for the pollutant.

attainment: Any area (other than an area identified as nonattainment) that meets the national primary or secondary ambient air quality standard for the pollutant.

unclassifiable: Any area that cannot be classified on the basis of available information as meeting or not meeting the national primary or secondary ambient air quality standard for the pollutant.
- Unclassifiable/attainment means the area is either unclassified or has attainment status. Unclassifiable areas are generally presumed to have acceptable air quality. Areas which are not designated for lead have no major lead emission sources.

Table 7-3 Air Quality Monitoring Data for the Olin Charleston Plant Area

Pollutant (unit)	Averaging Time	NAAQS		Tennessee AAQS		Monitoring Station County (year) ¹	Monitoring Station Data	
		Primary Standards	Secondary Standards	Primary Standards	Secondary Standards		Averaging Time	Concentration ²
SO ₂ (ug/m ³)	annual ³ 24-hour 3-hour	80 365 -- ⁵	-- ⁵ -- ⁵ 1300	80 365 -- ⁵	-- ⁵ -- ⁵ 1300	47-001-0004 Bradley (94)	annual 24-hour 3-hour	5 ⁶ 15 37
						47-001-0102 Bradley (93)	annual 24-hour 3-hour	27 93 223
						47-107-0101 McMinn (94)	annual 24-hour 3-hour	21 58 182
NO ₂ (ug/m ³)	annual ³	100	100	100	100	47-001-0102 Bradley (93)	annual	15
						47-001-0004 Bradley (94)	annual	5.46
						47-107-0101 McMinn (94)	annual	14
PM ₁₀ (ug/m ³)	annual ³ 24-hour	50 150	50 150	50 150	50 150	47-001-0103 Bradley (93)	annual 24-hour	24 53
						47-001-1003 Bradley (94)	annual 24-hour	25 ⁶ 32
						47-107-0101 McMinn (93)	annual 24-hour	31 70
						47-001-0103 Bradley (94)	annual 24-hour	32 ⁶ 110
						47-001-1002 Bradley (93)	annual 24-hour	31 81
						47-107-0101 McMinn (93)	annual 24-hour	42 122
O ₃ (pg/m ³)	1-hour	235	235	235	235	47-011-0004 Bradley (94)	1-hour	110
Pb (pg/m ³)	3-month	1.5	1.5	1.5	1.5	Not monitored		
CO (mg/m ³)	8-hour	10	-- ⁵	10	10	Not monitored		
	1-hour	40	-- ⁵	40	40			

Source: Tennessee Department of Environment and Conservation Air Pollution control Division and EPA Aerometric Information Retrieval System (AIRS)

Notes: 1. Most recent data presented.
 2. Maximum concentration for the indicated averaging time.
 3. Annual arithmetic mean.
 4. Annual geometric mean.
 5. No standard exists.
 6. Mean does not satisfy summary criteria, per EOA report notes (i.e., insufficient number of data points to qualify as calculated mean for NAAQS reporting).

Soils at the OCP may include Emory, Sequoia, Litz, Cumberland, and Etowah Series; however, over much of the site these soils have been subject to borrow activities and subsequent erosion. The remaining in-place soils are residual soils closely resembling the parent rocks. Bruno and Huntington Series Soils are indicated in the floodplain along the Hiwassee River. The soil thickness at the site is very erratic, ranging from none, where rock outcrops occur, up to 56 feet beneath the existing ground surface. The residual soils at the site consist of very soft to very hard yellow, tan, brown, and red brown clayey silts (Unified Classification MH and ML).

The OCP is located in Seismic Zone 2. The seismic zones provide guidance on building design. Zone 1 requires the least stringent building design while higher zone numbers require more stringent building design.

7.2.3 Disposal Sites

As discussed in Section 6.1.3.3, OCP is a large quantity generator of waste. Ash from a commercially licensed thermal mercury recovery unit is stored in a hazardous landfill. OCP also generates gypsum and chlorine salts which are stored in two on-site Class II landfills. In addition to the active sites, OCP has 3 inactive disposal sites that have mercury and chlorine contamination.

7.3 Water Resources

7.3.1 Surface Water

The Hiwassee River and its tributaries (particularly South Mouse Creek, North Mouse Creek and Candies Creek) constitute the major surface water features in the site area. The OCP is located at approximately Hiwassee River Mile (HiRM) 17. The Hiwassee River is a major tributary to the Tennessee River. The confluence of the Hiwassee River with the Tennessee River is in Chickamauga Reservoir at Tennessee River Mile 499. The lower portion of the Hiwassee River is impounded by backwater from Chickamauga Dam. The flow from the entire Hiwassee River watershed contributes approximately 16.5 percent of the flow through Chickamauga Reservoir. There are two cities located in the vicinity of the project site: Cleveland, located about 10 miles to the southwest; and Calhoun, located 2 miles to the north, across the river in McMinn County.

7.3.1.1 Water Usage

Industrial and municipal users of surface water along the Hiwassee River in Bradley and McMinn Counties include: 1) Bowater Southern Paper Company, in McMinn County; 2) the municipality of Etowah, Etowah Utility District, in McMinn County; 3) the municipality of Cleveland, Cleveland Utilities, in Bradley County; 4) the municipality of Charleston, Hiwassee Utility Commission, in Bradley County; and 5) Olin Corporation. In 1993, these users diverted the following: Bowater, .54 mgd; Etowah, 1.65 mgd; Cleveland, 6.58 mgd; Charleston, 2.87 mgd. (Ref 2). Water usage for the OCP, 4.6 mgd, is detailed in Section 6.1.3.2. (Ref. 2).

7.3.1.2 Water Quality

The Tennessee Valley Authority (TVA) through the Hiwassee River Action Team assesses the water quality of the Hiwassee River. In 1994, at HiRM 8.5 the fish assemblage was rated "good", the benthic assemblage rated "fair", and there was no significant sediment toxicity. The fish assemblage at HiRM 38 was rated as "marginal" in 1994, however in 1992 and 1993 it was rated "good". (Ref. 3)

7.3.1.3 Flood Plain

The OCP is located on the Hiwassee River at river mile 17. Flood protection for the OCP is provided by the TVA's system of locks and dams along the Tennessee, Ocoee, and Hiwassee Rivers. The dams which provide protection for the OCP are the Chickamauga Dam at Tennessee River Mile 471, 45 miles downstream; the Watts Bar Dam on the Tennessee River upstream of the confluence of the Hiwassee and Tennessee Rivers; the Appalachia Dam on the Ocoee River and the Hiwassee Dam at HiRM 76, 59 miles upstream.

Based on the latest available Federal Emergency Management Administration (FEMA) 1991 Flood Hazard Boundary Map, the project site is above the 100 year flood plain elevation of approximately 695 ft (Ref. 4). However, the FEMA map incorrectly shows OCP's existing rail yard is within the predicted 100 year flood plain. Topographic maps of the project site provided by Olin indicate that both the project site and rail yard are above the predicted 100 year flood plain level (Ref. 5). A certified topographic map of the project site and rail yard has been prepared and a Letter Of Map Amendment has been submitted to FEMA to correct the Flood Hazard Boundary Map to accurately reflect the true elevations in the rail yard.

7.3.1.4 Wetlands

According to the National Wetlands Inventory Map numerous scattered wetlands occur along the Hiwassee River, South Mouse Creek, and Candies Creek. These wetlands are primarily of the Lacustrine and Palustrine system types. A sluice adjacent to the project site is shown as a Lacustrine wetland; however, the project will not be built in nor impact this wetland. (Ref. 6) DOE request for concurrence with the Tennessee Department of Environment and Conservation will identify any high quality natural wetland communities in the project area.

7.3.2 Groundwater

7.3.2.1 Groundwater Usage

Groundwater in the Valley and Ridge Province occurs in unconsolidated aquifers, carbonate aquifers, and in fractured non-carbonate aquifers. The groundwater contours are generally a subdued replica of the ground surface. Recharge to these aquifers comes from infiltrating precipitation. There are no known high capacity users (>0.1 mgd) of groundwater in Bradley or McMinn Counties (Ref. 2).

7.3.2.2 Monitoring

Groundwater contamination from the three inactive disposal sites discussed in Section 7.2.3 has been found to be minor. A series of groundwater monitoring wells has shown only minor levels of mercury and chlorides in the surface groundwater local to each site. No mercury has been detected in the bedrock aquifer at any site. The discharge rate of the mercury and chlorides to the ultimate discharge point, the Hiwassee River, is orders of magnitude less than the NPDES permitted discharge to the river.

7.4 Ecological Conditions

7.4.1 Aquatic

Aquatic environments in the area of the OCP include the Hiwassee River and Chickamauga Reservoir. The Hiwassee River Watershed has an average area of 2700 square miles and an average annual discharge to the Tennessee River of 5640 cfs. The confluence of the Hiwassee River with the Tennessee River is in Chickamauga Reservoir, about 17 miles downstream of OCP. The lower portion of the Hiwassee River is impounded by backwater from Chickamauga Dam. The impounded portion of the Hiwassee River forms a large embayment (about 6500 surface acres) which extends over 20 miles up the Hiwassee River.

7.4.2 Terrestrial

Common species of wildlife in Tennessee include red and grey fox, mink, raccoon, striped skunk and weasel. Deciduous plant life dominates the area. Forests of yellow pine and hardwood are the most common with dense undergrowth of small trees and shrubs. Much of the undergrowth consists of mountain laurel, azalea, and dogwood. (Ref. 7) Cropland is also common in the area.

7.4.3 Threatened and Endangered Species

Two agencies were contacted to obtain information on threatened and/or endangered species in the project area. The U.S. Fish and Wildlife Service (USFWS) monitors federally-listed plants and animals. The USFWS provided reports of species whose range includes the site. The Tennessee Department of Environment and Conservation, National Heritage Program (NHP) monitors federally- and state-listed plants and animals. The NHP reported all threatened and/or endangered species documented to occur within Bradley County (Ref. 8). For a list of rare, threatened, or endangered species in the area, see Table 7-4 (Ref. 8 & 9).

There are seven animal species of federal concern in Bradley County. The NHP confirms occurrence of the Blue Shiner (*Cyprinella Caerulea*), Coldwater Darter (*Etheostoma Ditrema*), Trispot Darter (*Etheostoma Trisella*), Frecklebelly Madtom (*Noturus Munitus*), Amber Darter (*Percina Antesella*), and Conasauga (Reticulate) Logper (*Percina Jenkinsi*) within Bradley

County (Ref. 8). See Table 7-4 for a listing of these species along with their federal and state designations.

Table 7-4 Species of Concern

Species	Status	Source
Plants		
Canada Lilly (<i>Lilium Canadense</i>)	ST	TN NHP
Swamp Lousewort (<i>Pedicularis Lanceolata</i>)	ST	TN NHP
Maryland Milkwort (<i>Polygala Mariana</i>)	SS	TN NHP
Vertebrates (Fish)		
Blue Shiner (<i>Cyprinella Caerulea</i>)	SE, LT	TN NHP
Coldwater Darter (<i>Etheostoma Ditrema</i>)	ST, C2	TN NHP
Snail Darter (<i>Percina Tanasi</i>)	LT	USFWS
Trispot Darter (<i>Etheostoma Trisella</i>)	ST, C2	TN NHP
Frecklebelly Madtom (<i>Noturus Munitus</i>)	ST	TN NHP
Amber Darter (<i>Percina Antersella</i>)	SE, LE	TN NHP
Conasauga Logper (<i>Percina Jenkinsi</i>)	SE, LE	TN NHP
SE = State endangered LE = Federally endangered ST = State threatened LT = Federally threatened SS = State special concern C2 = Under federal review TN NHP = Tennessee Natural Heritage Program USFWS = United States Fish and Wildlife Service		

The USFWS reports that the federally threatened snail darter (*Percina Tanasi*) may occur in the project impact area (Ref. 9).

Additionally, the Tennessee NHP has reported three state-listed plants (none is federally listed) within Bradley County (Ref. 8). See Table 7-4 for a complete listing of these plants.

7.5 Socioeconomic Resources

7.5.1 Socioeconomic Characteristics

The Bradley County population at the 1990 census was 73,712, an increase of 4.8% over the population recorded during the 1980 census (Ref. 10). The estimated population in 1994 is 78,100. Excluding agriculture, the major employment sectors in Bradley County are

manufacturing, 48.4%, wholesale & retail, 20.1%, service, 20.8, and government, 11.7%. The median household income is \$25,678. (Ref. 11)

7.5.2 Transportation

Access to the plant is via Lower River Road off of State Highway 11. Highway 11 runs north-south about a mile east of OCP. In 1993, the average daily traffic volume for Lower River Road between State Highway 11 and Interstate 75 was 1,890. The average daily traffic volume along Highway 11 south of Lower River Road was 9,810 while the volume was 32,420 on Interstate 75. (Ref. 12). A Norfolk Southern rail spur serves the facility.

OCP currently receives about 350 commercial truck deliveries, 35 rail car deliveries, and 5 barge deliveries per week. Additionally, OCP currently sends out 700 trucks and 100 rail cars per week, and 5 barges per month. Employee passenger vehicle traffic averages about 3,000 trips per week.

7.6 Aesthetic/Cultural Resources

7.6.1 Archaeological/Historical Resources

The Tennessee Historical Commission has reviewed the proposed project and determined it will have no effect upon National Register of Historic Places listed or eligible properties (Ref. 13).

7.6.2 Native American Resources

The federal government does not recognize any Native American tribes in Tennessee (Ref. 14).

7.6.3 Scenic/Visual or Recreational Resources

There are no scenic or visual resources in the vicinity of the OCP. The Hiwassee River is designated as a Class III (Developed River Area) state scenic river in Polk County, approximately 15 miles upstream of Charleston (Ref. 15).

The Hiwassee River and Chickamauga Reservoir are considered recreational waters. Additionally, within a 15 mile radius of the project site is the Cherokee National Forest as well as two wildlife management areas: Candies Creek Wildlife Management Area, and Rogers Creek Wildlife Management Area (Ref. 16).

7.7 References

7.7.1 Cited References

1. National Oceanic and Atmospheric Administration. Chattanooga TN Climatological Data, 1992 and 1993 Annual Summary with Comparative Data.

2. Fax transmittal. Tom Moss, Tennessee Department of Environment and Conservation, Division of Water Supply, to Clay Leonard, NOXSO Corporation, February 6 & 9, 1995. Bradley and McMinn County surface and ground water users.
3. Letter and enclosures from Janice Cox, Tennessee Valley Authority, Hiwassee River Action Team, to Steve Barnes, Olin Corporation, February 7, 1995.
4. Federal Emergency Management Agency, National Flood Insurance Program. Flood Insurance Rate Map, Bradley County, Tennessee. September 4, 1991.
5. Olin Topography Map, Drawing No. D-T627-430-10-6.
6. U.S. Department of the Interior, Fish and Wildlife Service, National Wetlands Inventory Map.
7. Encyclopedia Americana Vol. S-T pg 476, Copyright 1984, Grolier Inc.
8. Fax transmittal. William M. Christie, Tennessee Department of Environment and Conservation, Ecological Services Division, to Everett Howser, Olin Corporation, February 13, 1995.
9. Fax Transmittal. Jim Widlack, U.S. Department of the Interior, Fish and Wildlife Service, to Clay Leonard, NOXSO Corporation, February 3, 1995.
10. U.S. Department of Commerce, 1990 census.
11. Fax Transmittal. Cleveland/Bradley Chamber of Commerce to Jack Browning, NOXSO Corporation, March 14, 1995.
12. 1993 Bradley County Traffic Map, Tennessee Department of Transportation, Bureau of Planning and Development.
13. Letter from Herbert L. Harper, Tennessee Historical Commission, to Clay Leonard, NOXSO Corporation, February 23, 1995.
14. U.S. Department of Interior, Bureau of Indian Affairs, Tribal Government Services. Listing of federally recognized native American Indian tribes.
15. Fax Transmittal. Tennessee Department of Environment and Conservation, Bureau of State Parks, to Jack Browning, NOXSO Corporation, March 14, 1995. Listing of Tennessee State Scenic Rivers.
16. USGS Charleston, TN 7.5-minute quadrangle topographic 1980.

7.7.2 Uncited References

Olin Corporation

8 CONSEQUENCES OF THE NOXSO DEMONSTRATION PROJECT AT THE OCP

8.1 Air Quality Impacts

Including SO₂, the proposed project will not increase OCP emissions of any of the National Ambient Air Quality Standards (NAAQS) criteria pollutants. Construction impacts on air quality are expected to be insignificant.

8.1.1 Liquid SO₂ Plant Construction Impacts

Air emissions from construction activities will primarily result from the operation of diesel and/or other internal combustion-powered construction equipment. The levels and duration of these emissions are not expected to exceed that which is normally generated at a typical construction project of similar size. Fugitive dust will be generated from excavation, general construction activities, and vehicular traffic. Industry standard practices will be employed for dust suppression and control of fugitive emissions, including tarping vehicles, and utilizing water-sprays and chemical suppressants. Emissions from mobile sources will be kept in conformance with applicable standards for the particular piece of equipment or vehicle.

8.1.2 Liquid SO₂ Plant Operation Impacts

As discussed in Section 7.1.1, morning fog is common in the project area. The primary source of atmospheric water vapor is evaporative water loss from the Hiwassee River. Drift and evaporative water losses from the OCP cooling towers are an insignificant source of atmospheric water vapor in the project area. Including the increased load on the existing cooling towers and the ASU cooling tower the proposed project will increase drift and evaporative water losses from the OCP by about 2%. Based on the above information the proposed project will have an insignificant effect on fog formation in the project area.

As discussed in Section 6.2.1.1, a caustic scrubber will be used to remove SO₂ from a process vent stream. Based on operating experience at the 9000 tpy commercial Calabrian unit, the scrubber will remove essentially 100% of the SO₂ in the vent stream. Using EPA Method 6, *Determination of Sulfur Dioxide Emissions From Stationary Sources*, which has a minimum detection limit of about 2 ppm, no SO₂ has been detected in the commercial unit's vent stream after scrubbing. Therefore, based on an SO₂ vent stream concentration of < 2 ppm, emissions from the 45,000 tpy liquid SO₂ plant will be less than 1 lb/yr.

However, the proposed project will more than offset the potential vent stream emissions by reducing fugitive emissions from transfer line disconnections. A small amount of fugitive SO₂ escapes to the atmosphere when transfer lines used during liquid SO₂ loading or unloading are disconnected. Because rail cars carry 4.5 times more SO₂ than tank trucks, transfer line breaks will be less frequent with the proposed project even though similar quantities of SO₂ would undergo vehicle transfers. Due the proposed project it is estimated fugitive SO₂ emissions from transfer line breaks at the OCP will decrease from 200 lbs per year to 56 lbs per year.

The NaOH solution used in the scrubber will react with the SO₂ to form a sodium sulfite (Na₂SO₃) solution. Sodium sulfite is currently used by Olin to neutralize a chlorine waste stream generated by another process. Sodium sulfite generated by the caustic scrubber will replace a portion of Olin's current consumption.

The liquid SO₂ process will not have emissions of any other NAAQS criteria pollutant.

There will be no NAAQS criteria pollutant emissions from the air separation plant. However, the argon and the majority of the nitrogen separated from the oxygen will be vented back to the atmosphere.

8.2 Land-Use Impacts

As shown in Figure 8-1, the liquid SO₂ process and air separation unit (ASU) will be installed at the Olin facility east of the existing switchgear building in an area about an acre in size. The site lies within the current plant boundaries, thus, no additional acreage will be required. No toxic or hazardous waste materials are expected to be encountered during construction. Utilities will be routed to the site and a rail spur will be constructed from the existing rail system to provide adequate space for sulfur and SO₂ rail cars.

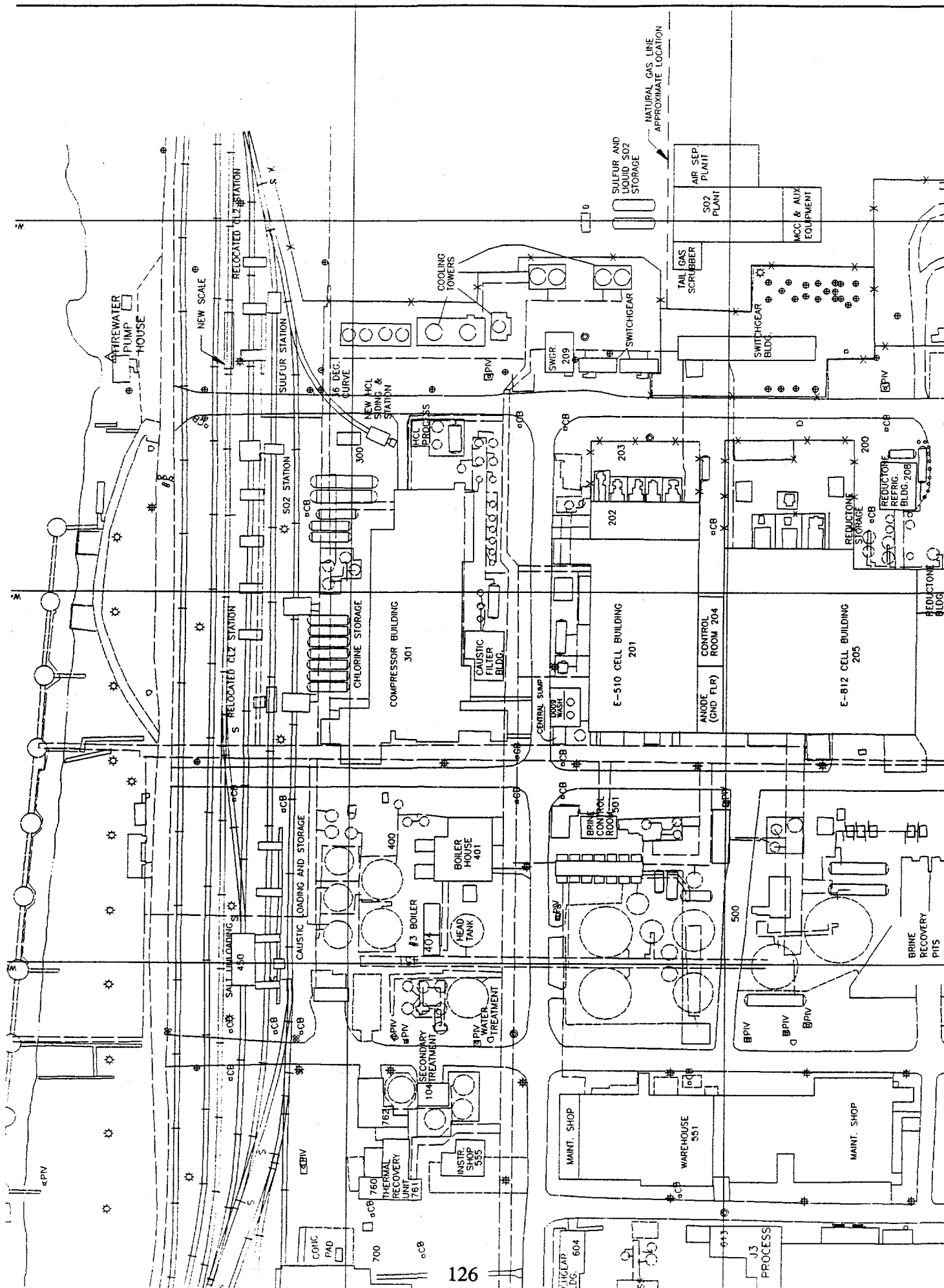
8.2.1 Construction Impacts

The following discussion presents potential land-use impacts for the Liquid SO₂ Plant. In general the modular skid mounted design of the Calabrian Liquid SO₂ Process and the ASU will minimize onsite construction. A geotechnical survey involving standard penetration tests will be conducted to determine soil characteristics for design engineering. Construction activity will begin with clearing and grubbing. Based on foundation design and results from the geotechnical survey, excavation and replacement of current material with new backfill may be necessary. After grading and compaction, foundation work will begin. Driven pilings may be required for deep supports. Medium to shallow foundations will be supported by spread footings.

Soil loss will be controlled during construction by berming, silt fencing, netting, wetting, and other general construction practices which are typically used to prevent erosional loss. The general elevation of the area will be maintained above the predicted 100-year flood frequency elevation of 695 feet. (See Section 7.3.1.3)

The existing rail yard is crowded and will require reworking to provide adequate room for sulfur rail car unloading and liquid SO₂ rail car loading. The major rail work entails building a rail spur and a new hydrochloric acid loading station to move the existing acid rail traffic off of the main rail yard. In addition, a rail car loading scale, a sulfur loading station, and a SO₂ reconditioning station will be added while a rail track crossover and two chlorine (Cl₂) reconditioning stations will be relocated. The rail yard modifications are shown on Figure 8-1. Process water and cooling water capacities are adequate to meet the needs of the project. However, a supply network will have to be constructed to extend these supplies to the site. No previously undisturbed land will be utilized by the project. Construction will occur within the

Figure 8-1. Liquid SO₂ Plant Location



Olin site and all land has been previously disturbed and filled to a level above the 100-year flood plain.

8.2.2 Liquid SO₂ Plant Operation Impacts

The following subsections detail the impacts on primary resource requirements for the Olin facility based on the liquid SO₂ plant resource requirements discussed in Section 6.1.4. Resource requirements shown for the liquid SO₂ plant are based on the maximum plant capacity of 45,000 tpy. Chemical feed stocks used by the OCP which are not impacted by the liquid SO₂ plant are not discussed. Table 8-1 summarizes the quantities and relative changes in resource requirements for the Olin facility and the proposed project.

Table 8-1 OCP Resource Requirement Impact Summary

Resources	OCP Requirement	Requirement with SO ₂ Plant	Actual Change	% Change
Caustic (tpy)	Unknown	5,712	5,712	NA
Electricity (MWh/yr)	1.1 * 10 ⁶	9,636	9,636	<1
Fuel Oil (gpy)	230,000	0	0	0
Labor (#)	625	629	4	1
Land (acres)	975	975	0	NA
Liquid SO ₂ (tpy)	20,000	0	-20,000	NA
Oxygen (tpy)	0	22,950	22,950	NA
Sulfur (tpy)	0	23,130	22,130	NA
Water (mgd)	4.6	0.03	4.63	<1

8.2.2.1 Caustic

Operation of the liquid SO₂ plant will require about 5,712 tpy of 20 wt. % sodium hydroxide solution. OCP currently has a net production capacity of about 784 tpd (286,160 tpy) of caustic.

8.2.2.2 Electrical Power

It is estimated the operation of the liquid SO₂ plant will require about 1,100 kW or 9,636 MWh/yr. A new unit substation will be installed to supply the additional power requirements of the liquid SO₂ plant. The OCP power requirement is currently about 128,000 kW or 1.1 * 10⁶ MWh/yr.

8.2.2.3 Fuel Oil

No additional fuel oil will be required for the operation of the liquid SO₂ plant.

8.2.2.4 Labor

Construction of the liquid SO₂ plant will require an estimated 20 supervision and construction labor personnel. Operation will add an anticipated 4 personnel to the 625 person workforce already employed at the OCP. The increase provides a net positive economic impact for Bradley county. For additional discussion on the socioeconomic impact see section 8.6.

8.2.2.5 Land

The liquid SO₂ plant will occupy less than an acre of the 975 acre Olin site. The land required for this project is presently owned and occupied by Olin. The project will neither require additional off-site property nor disturb present OCP operation conditions.

8.2.2.6 Oxygen

The liquid SO₂ process will require about 22,950 tpy of 99.5% pure oxygen. As discussed previously, the oxygen will be supplied by a dedicated air separation unit.

8.2.2.7 Sulfur

The liquid SO₂ plant will consume about 23,130 tpy of sulfur of which about 16,060 tpy will be supplied by the sulfur recovery unit at Alcoa's Warrick Power Plant. The additional sulfur required will be purchased from the open market.

8.2.2.8 Water

Operation of the liquid SO₂ plant will require about 0.03 mgd of makeup water. The water will be provided by the Hiwassee river and treated in existing water treatment facilities prior to its use. OCP currently uses about 4.6 mgd.

8.2.3 Liquid SO₂ Plant Demolition Impacts

Following the two year demonstration portion of the design/construct/operate phase of the project, the liquid SO₂ plant will be operated commercially and therefore demolition will not be required.

8.2.4 Liquid SO₂ Production Impact

The maximum production rate of liquid SO₂ will be about 5.1 tons per hour (45,000 tpy), and it will be stored in an above ground 150 ton capacity storage tank. Approximately 20,000 tpy will be used as feed stock at the OCP, 12,000 tpy will be shipped by rail to an Olin facility in

Augusta Georgia, and the remainder will be sold on the open market. Based on historical trends, U.S. merchant consumption of liquid SO₂ in 1996 is expected to be about 360,000 tpy. (Ref. 1) The anticipated plant production rate of 45,000 tpy will initially account for about 12% of the market.

The affect of the proposed project on the U.S. market is expected to be minimized by several factors. U.S. liquid SO₂ production accounts for about 75% of the merchant demand, with the remainder being imported primarily from Canada. (Ref. 1) Due to transportation costs, it is expected that the proposed project will displace a portion of the imported product. The current supplier to the OCP produces liquid SO₂ as a limited quantity byproduct of sulfuric acid production. It is possible this supplier may stop liquid SO₂ production and shift the capacity to sulfuric acid production. In addition, at the current market growth rate, by the year 2000 the U.S. merchant demand will have adsorbed the proposed project's 45,000 tpy capacity.

8.3 Waste Disposal

8.3.1 Liquid SO₂ Plant Construction Impacts

Paints, solvents and other, primarily petroleum-based construction products will be purchased in quantities so that their on-site consumption minimizes the generation of potentially hazardous wastes. Although an exact estimate can not be accurately made, the quantity of these wastes is believed to fall within the RCRA Small Quantity Generator restrictions. Any hazardous wastes generated will be treated and/or disposed of at a licensed facility. It is not anticipated that the NDP will generate any acutely hazardous waste.

Miscellaneous construction debris including scrap steel, rubble, wood, etc. will be appropriately characterized for proper disposal at either a salvage yard or licensed construction landfill. In general the modular skid mounted design of the Calabrian liquid SO₂ Process and ASU will minimize onsite construction and therefore the generation of on-site debris.

8.3.2 Liquid SO₂ Process Operation Impacts

Approximately twenty 30 gallon drums of an ash material will be removed from the molten sulfur storage tank and molten sulfur day tank during the annual maintenance outage. The ash material is believed to be iron oxides (products of corrosion) and carbon and ash impurities from the molten sulfur. According to Texas regulations the material is not considered hazardous material; however, no TCLP or analysis has been performed on the ash. The material will be analyzed and disposed of according to the applicable state and federal regulations.

8.3.3 Air Separation Unit Operation Impacts

The zeolite molecular sieve material used to remove carbon dioxide and moisture is composed of porous crystalline aluminosilicates. Aluminosilicates are an assemblage of silicon oxide (SiO₄) and alumina (AlO₄) crystals; some of the same chemical compounds found in the NOXSO sorbent. (Ref. 2) The amount of zeolite material contained in the ASU or its life expectancy is

not known at this time. No hazardous constituents are expected to be adsorbed on the zeolite and the zeolite itself is not classified as a hazardous material. The used zeolite material will be properly disposed of in accordance with federal and state solid waste regulations.

The hydrocarbon adsorber contains silica gel (SiO_2); the amount and service life is not known at this time. The silica gel is not classified as a hazardous material; however, the used gel will be disposed of in accordance with federal and state solid waste regulations.

8.4 Water Quality Impacts

Construction and operation of the liquid SO_2 plant will have no significant impact on groundwater or surface water quality. The operating mode of the liquid SO_2 plant will virtually eliminate the possibility of harm to the quality of the waters surrounding the OCP. Tennessee Bureau of Environment, Division of Water Pollution Control officials will be informed of the wastewater additions as a result of the proposed project and the National Pollutant Discharge Elimination System (NPDES) permit will be modified if required. The following discussion reviews water quality impacts for both components of the liquid SO_2 plant.

8.4.1 Liquid SO_2 Plant Construction Impacts

8.4.1.1 Groundwater

The potable groundwater aquifers in the immediate area of the plant occur in unconsolidated aquifers, carbonate aquifers, and in fractured non-carbonate aquifers. During construction, environmental impacts resulting from the infiltration of surface waters should be negligible due to both the relatively short duration of construction/earth work activities and the size of affected area. Foundations for process equipment will have footings in the alluvium/till, or will rest on pilings driven to bedrock. The risk to groundwater from surface infiltration through fractures or channeling around foundations will be minimized using generally accepted construction and installation methods which normally minimize the flow of water around foundations to insure structural integrity.

8.4.1.2 Surface Water

A slight increase in run-off may occur during construction. Soil loss will be controlled during construction by berming, silt fencing, netting, wetting, and other general construction practices which are typically used to prevent erosional loss.

8.4.2 Liquid SO_2 Plant Operation Impacts

8.4.2.1 Ground Water

No process or cooling water will be discharged into groundwater aquifers beneath the site.

8.4.2.2 Surface Water

Supply

Process and cooling water for OCP are obtained from the Hiwassee River. Current surface water withdrawal is about 4.6 mgd. The incremental increase, due to the liquid SO₂ plant, 0.03 mgd, is negligible and will have no impact on surface water supply.

Discharge

All wastewater discharges from OCP are to the Hiwassee River and are monitored by Olin as required under their existing NPDES permit. The liquid SO₂ plant will generate about 5 gpm (0.008 mgd) of industrial wastewater. Of this total about 1 gpm will be waste heat boiler blowdown from the liquid SO₂ process, the remaining 4 gpm will be cooling water blowdown. Of the 4 gpm of cooling water blowdown about 3 gpm will be from the ASU cooling tower with the remainder due to the increased load on the existing OCP cooling towers. The characteristics of the boiler blowdown will be typical of boiler blowdown from the OCP since the same feed water is used. Boiler blowdown from the liquid SO₂ plant will be commingled with OCP boiler blowdown, monitored, treated in OCP's existing phosphate treatment system, and discharged in accordance with the NPDES permit limitations for Outfall 001. The existing cooling tower system at OCP has sufficient excess capacity to provide the cooling water requirements of the liquid SO₂ plant. The existing molybdate based cooling water blowdown treatment system also has the capacity to treat the additional 4 gpm of cooling water blowdown. After treatment the cooling water will be discharged in accordance with the permit limitations for Outfall 001. As shown in Table 6-1, the average flow from Outfall 001 is about 500 gpm thus no impacts to surface water quality are anticipated from the slight increase in wastewater generated from this source.

8.4.2.3 Stormwater

Stormwater run-off from the liquid SO₂ plant will be generated from roof drains, paving, and other miscellaneous surface facilities. Slight increases over the baseline conditions in run-off volume are anticipated from these artificial surfaces. The characteristics of this stormwater are not anticipated to vary from present sources. Drains in the project area will be routed to existing storm sewers which are designed to adequately handle this slight increase in volume. An estimated discharge quantity can be determined once preliminary design is completed. The stormwater runoff will be discharged through Outfalls 002, 003, and 004. No significant adverse impacts to surface water quality are anticipated from this slight increase in stormwater discharge.

8.4.2.4 Thermal

OCP averages about 4.1 mgd of wastewater discharge to the Hiwassee River. The proposed project will increase the discharge by about 0.008 mgd and thus is not expected to significantly impact the thermal discharge from the OCP.

8.5 Ecological Impacts

The greatest concern for possible ecological impacts as a result of the proposed project are SO₂ emissions. However, no significant threat or ecological impact is foreseen from the construction or operation of the liquid SO₂ plant.

8.5.1 Construction Impacts

The OCP was constructed in the early 1960's and has been expanded several times since. The OCP property has been backfilled with local soils to a level above FEMA 100 year flood plain level. The liquid SO₂ plant will require about an acre of this previously disturbed land. The area is unutilized Olin property and therefore neither plant and/or wildlife habitats nor wetland areas will be disturbed by the construction of the NDP.

8.5.2 Operation Impacts

The proposed project will have negligible adverse impacts on ecological systems. Project wastewater discharges are minimal and no NAAQS criteria pollutants will be emitted.

8.6 Socioeconomic Impacts

Overall, the NDP should have a beneficial effect on the Bradley County area. Construction and operations personnel will increase employment in the local area. Steel, concrete, and other building materials will be locally supplied. The impacts of construction and operation of the liquid SO₂ plant are discussed below. No significant adverse socioeconomic impacts are anticipated.

8.6.1 Construction Impacts

The construction of the NDP should not have a significant impact on the local area as supported by the following findings.

8.6.1.1 Traffic Impacts

OCP currently receives about 350 commercial truck deliveries, 35 rail car deliveries, and 5 barge deliveries per week. Additionally, OCP currently sends out 700 trucks and 100 rail cars per week, and 5 barges per month. Employee passenger vehicle traffic averages about 3,000 trips per week. Construction related trips have been estimated based on the number of construction workers and equipment deliveries anticipated over the construction period. Assuming a maximum of 20 construction workers will be employed, 2 equipment deliveries per day, and a five-day work week about 110 additional weekly trips into and out of the plant are expected. Based on this estimate, truck traffic is expected to increase by about 1% while passenger vehicle traffic is expected to increase by about 3%.

Traffic will not be adversely affected within OCP. Previous construction/maintenance projects employing a comparable or greater number of workers have had little or no impact.

As mentioned in Section 7.5.2, access to the site is via Lower River Road off of State Highway 11 or Interstate 75. In 1993, the average daily traffic volume on Lower River Road between State Highway 11 and Interstate 75 was 1,890. The average daily traffic volume along Highway 11 south of Lower River Road was 9,810, while the volume was 32,420 on Interstate 75. Assuming that all the construction traffic comes from south of OCP, i.e., the Cleveland city area, and further more that it is split equally between Highway 11 and Interstate 75 the week day traffic volume on both roads will increase by less than 1%. In addition, the week day traffic volume on Lower River Road will increase by about 1%. (Ref. 3)

8.6.1.2 Noise

Potential socioeconomic noise impacts during construction are expected to affect two classes of people: (1) the workforce and (2) the residents in the surrounding community. Based on the following findings, no adverse noise impacts are anticipated from the liquid SO₂ plant construction.

- Workforce

The noise associated with construction activities will cause a small increase in noise levels in adjacent areas. These noise levels should not exceed 85 to 88 dBA at distances of 250 to 500 feet away from the proposed construction activities. With the exception of pile driving, if required, the noise levels will not be noticeably higher than background noises at distances greater than 500 feet. The noise levels from pile driving will be intermittent and will not exceed the OSHA permissible noise exposure limit of 140 dBA for impact noise. No adverse noise impacts on the workforce are anticipated from the proposed project.

- Public

The closest residential receptor is about 3/4 miles from the proposed project site. Typical construction activities are not expected to result in noise levels above the normal daylight nuisance noise level. Construction activities which have the potential for generating significant amounts of noise, i.e., pile driving, will be limited to daylight hours. Therefore, adverse noise impacts are not expected to the surrounding community.

8.6.1.3 Public Services

Electricity, water, and a sanitary sewer system are currently on-site and will be sufficient to meet construction needs. Local fire and police departments and health care facilities are not anticipated to be adversely affected.

8.6.1.4 Land Usage

Construction of the liquid SO₂ plant will take place on OCP property and will not encroach on any surrounding public or private property. Land usage is not expected to be adversely affected.

- Federally Endangered Species

The DOE contacted the Department of Interior, Fish and Wildlife Service, concerning the impact of the liquid SO₂ plant on federally threatened or endangered species. Upon review, the Fish and Wildlife Service indicated the proposed project is not likely to adversely affect the federally threatened snail darter (Ref. 4).

- Archeological, Cultural & Historic Properties

The Tennessee Historical Commission was contacted by DOE and has indicated that the proposed project will not affect any resources eligible for listing in the National Register of Historic Places (Ref. 5).

8.6.1.5 Population

Although a small number of workers may take up residence in hotels or apartments within the area during construction, no extended change in population is expected from the construction of the liquid SO₂ plant.

8.6.1.6 Health and Safety

Potential socioeconomic health and safety impacts during NDP construction are anticipated to affect both the on-site workforce and the surrounding community. Based on the following findings and implementation of appropriate engineering controls, no significant adverse health and safety impacts from construction are anticipated.

- Workforce

A construction safety program will be written, and implemented for the proposed project to minimize the occurrence of accidents. Specific standards set by OSHA will be targeted for training and inspection during the construction work. A written hazard communication program will be established to inform craftsmen of the hazard potential from chemicals used on-site. In addition, the modular, skid mounted design of the liquid SO₂ process and ASU will minimize on-site construction and thus reduce the opportunity for workplace accidents.

The education, engineering, and enforcement components of safety programs have been used to lower the rate of accidents on job sites. The workforce will be educated through new-hire orientations, safety meetings and personal communications. Human engineering eliminates unsafe acts by motivating employees to "think safely". Safety

engineering will be used to eliminate unsafe conditions through performance of hazard reviews, site inspections, and accident investigations. Line supervisors will enforce the rules of good safety practice and take disciplinary action when warranted. The work place health and safety program deters any significant health and safety impacts to craftsmen and equipment during the construction activities.

- Public

Community health and safety impacts during construction could be anticipated from fugitive emissions or improper solid waste disposal. Fugitive dust emissions during construction work will be controlled by wetting and/or other general construction practices when site conditions have the potential to impact either adjacent on-site areas or off-site locations. Typical construction hazardous wastes include paint and solvent wastes. All hazardous waste generated during construction will be properly containerized, temporarily stored with compatible wastes, labeled, and transported by a licensed shipper to an approved treatment, storage or disposal facility (TSDF). The transporter will be responsible for making appropriate notifications if any environmental release occurs during transportation. It is most likely that the quantity of material generated during construction activities will allow for project classification under the category of Conditionally Exempt Small Quantity Generator (CESQG). Hazardous wastes produced will be properly handled. If the on-site storage quantity exceeds 2200 lbs appropriate disposal and regulatory procedures will be followed.

Non-hazardous solid waste generated from construction, such as scrap materials, will be disposed of in an approved industrial (waste) landfill. No adverse community impacts are anticipated from these sources during construction.

8.6.2 Operation Impacts

Based on the following findings, operation of the liquid SO₂ plant is not expected to have any significant adverse socioeconomic impacts.

8.6.2.1 Traffic

OCP currently receives about 250 truck deliveries, 30 rail car deliveries, and 5 barge deliveries per week. Of the 250 truck deliveries about 10 per week are liquid SO₂. Additionally, OCP currently sends out 500 trucks and 80 rail cars per week, and 5 barges per month. Employee passenger vehicle traffic averages about 3000 trips per week. Four rail cars per week of sulfur will be off-loaded at the OCP, liquid SO₂ shipping can be accommodated with approximately 5 rail cars per week, increasing rail car traffic by about 4% . In addition, one full time employee per shift or 21 passenger vehicle trips per week will be required. As a result of the proposed project, liquid SO₂ will no longer be shipped by truck into the plant, decreasing truck traffic by about 1%.

As mentioned in Section 7.5.2, access to the site is via Lower River Road off of State Highway 11 or Interstate 75. In 1993, the average daily traffic volume on Lower River Road between State Highway 11 and Interstate 75 was 1,890. The average daily traffic volume along Highway 11 south of Lower River Road was 9,810, while the volume was 32,420 on Interstate 75. Assuming that all the operations traffic comes from south of OCP, ie., the Cleveland city area, and further more that it is split equally between Highway 11 and Interstate 75, the week day traffic volume on both roads will increase by much less than 1%. In addition, the week day traffic volume on Lower River Road will increase by less than 1%. (Ref. 2)

8.6.2.2 Noise

The two receptor groups of noise generated from liquid SO₂ plant operations are the workforce and residents in the surrounding communities. Based on the following findings, no significant adverse noise impacts from operations are anticipated.

- Workforce

The major sources of noise emissions will be from rotating process equipment including the liquid SO₂ plant sulfur pump and liquid SO₂ pump and the ASU centrifugal compressors and expansion turbine. Workforce noise is regulated by OSHA under 29 CFR 1910.25. This regulation requires engineering controls, administrative measures and hearing protection for noise exposures greater than 90 dBA for 8 hours. A hearing conservation program will be implemented as required if noise exposures are greater than or equal to 85 dBA for 8 hours. Annual audiogram and training will be incorporated into the hearing conservation program. Implementation of a hearing conservation program will assure that no significant adverse noise impacts on the workforce will result from the proposed project.

- Public

The noise sources from the NDP will produce a broad band noise spectrum. The resultant noise levels will consist of a composite of sounds with none being particularly dominant. Outdoor noise propagation from operations will be further attenuated by adjacent buildings, ground barriers, trees, and the distance through the atmosphere to receptors. Typical residential nuisance noise levels of 60 dBA (day time) and 50 dBA (night time) are not anticipated to be exceeded by NDP operations. Therefore, no significant adverse noise impacts to the surrounding community are anticipated.

8.6.2.3 Public Services

No additional public services other than those that were discussed in the construction phase, subsection 8.6.1.1., would be required during the 24-month operation of the NDP.

8.6.2.4 Land Usage

No additional land will be used during the 24-month operation of the NDP.

8.6.2.5 Population

No impact on the population is anticipated during the 24-month operation of the NDP.

8.6.2.6 Health and Safety

The two potential receptor groups of health and safety impacts from the liquid SO₂ plant operations are the on-site workforce and the surrounding community. The major health and safety hazard is the potential exposure to SO₂ from the liquid SO₂ process and storage tanks. As discussed in Section 4.6.2, SO₂ is considered an extremely hazardous substance. Several federal regulations establish lists of extremely hazardous substances, threshold planning quantities (TPQ), and facility notification responsibilities necessary for the development and implementation of emergency response plans. OCP is currently above the TPQ for liquid SO₂ and is in compliance with all applicable hazardous substance regulations. OCP currently stores about 190 tons of liquid SO₂ on-site, 100 ton in a storage tank and 90 ton in a rail car. The amount of liquid SO₂ stored on-site will increase to about 250 tons due to the proposed project; however, OCP's compliance with the hazardous substance regulations will not change. A discussion of these hazardous substance regulations is given in Section 9.6.2.

As discussed in Section 6.2.1, the Calabrian Liquid SO₂ Process is an advanced process designed for ease of operation and maintenance and to minimize process waste streams and emissions to the environment. A review of the 9,000 tpy commercial unit's operating history for 1992 through 1994 has shown only 3 SO₂ releases greater than the reportable quantity of 1 lb, of which none exceeded 3.5 lbs or required emergency services. The inclusion of operating experience learned from this commercial unit into the design for this project should eliminate the source of these releases. Any leaks from the equipment will be detected by ambient area safety monitors. The area safety monitors will be installed, operated and maintained following recommended industry practices.

Accident scenarios have been or will be performed by Olin for continued compliance with hazardous substance regulations. In addition, the use of safe engineering design, leak detection, and shut-off systems will permit the operation of the liquid SO₂ process and storage of liquid SO₂ with minimal concern for system failure. HAZOP procedures, a coordinated process hazard evaluation/safety review, will be used to identify, evaluate and control the hazards associated with the liquid SO₂ plant to ensure safe operation. All operations personnel will be trained to develop and maintain safe operating practices. Also, the liquid SO₂ process and ASU will be designed and constructed for the appropriate seismic zone and wind loadings for the Bradley County, Tennessee area. Therefore, no adverse health and safety impacts on the workforce or public from operations are anticipated.

Exposure to liquid SO₂ and also molten sulfur may occur from a shipping accident, however existing records indicate the likelihood of a train accident is small. Federal Railroad Administration (FRA) records indicate Norfolk Southern's train accidents and or derailments are among the industries lowest. During 1992 there were 46.3 reportable accidents per billion miles (131 train accidents/2.829 billion car miles) and in 1993 there were 39.5 reportable accidents per billion miles (113 train accidents/2.859 billion car miles). An FRA reportable accident is any accident with an estimated dollar damages of \$6,300 or greater. More specifically, over a 10 ten year period, 1985 to 1994, Norfolk Southern had one derailment of 6 cars containing liquid SO₂, of which 2 leaked, and one derailment of a car containing molten sulfur. (Ref. 6). In addition, the elimination of shipment of liquid SO₂ by truck to the OCP will reduce the likelihood of a shipping accident.

8.6.2.7 Pollution Prevention

Pollution prevention and waste minimization focus on reducing the amount and/or toxicity of pollutants generated by industrial processes. While pollution prevention is based upon controlling pollutants at their source, waste minimization also controls pollutants by process changes, as well as reuse and recycling practices. The Pollution Prevention Act of 1990 establishes a protection hierarchy of environmental management techniques, and in 1992 EPA issued a draft Federal Sector Strategy which calls for federal agencies to lead the nation in implementing pollution prevention policies and practices.

The proposed project incorporates several pollution prevention and waste minimization principles and techniques. The most significant technique is the basis of the Calabrian Liquid SO₂ Process. By combusting the sulfur with pure oxygen, process challenges of separating the SO₂ gas from incondensibles, and the waste streams which are produced, are eliminated. Also, production of a useable by-product, sodium sulfite, from the liquid SO₂ process vent scrubber rather than a waste sludge which requires disposal is a waste minimization technique.

8.7 References

8.7.1 Cited References

1. Selover Associates, NOXSO Process-Derived Sulfur Dioxide Preliminary Market Study. 1993
2. Ruthven, Douglas M., Principles of Adsorption and Adsorption Processes. John Wiley & Sons, 1984.
3. Tennessee Department of Transportation, Bradley County and Cleveland 1993 traffic maps
4. Letter from Robert T. Bay, U.S. Department of the Interior, Fish and Wildlife Service, to Joseph B. Renk III, U.S. DOE PETC. April 19, 1995
5. Letter from Herbert L. Harper, Tennessee Historical Commission, to Joseph B. Renk III, U.S. DOE PETC. April 5, 1995

6. Letter and Enclosures. D.L. Schoendorfer, Norfolk Southern, to Mark Woods, NOXSO Corporation, February 22, 1995. Federal Railroad Administration statistics for Norfolk Southern.

8.7.2 Uncited References

Olin Corporation
Calabrian Corporation

9 OCP APPLICABLE REGULATIONS

This section describes the federal and state regulatory compliance and permit requirements for the NOXSO Demonstration Project (NDP) at the Olin Charleston Plant (OCP).

9.1 Air Quality

Emission source activities at OCP are bound by Tennessee Air Pollution Control Regulations. Numerous facilities on the OCP are subject to these regulations. In addition to the state regulations, some of the operations at the OCP site are subject to federal requirements for regulating air pollutant emissions. Federal laws are applicable to all industrial sites nationwide and must be followed in addition to state requirements. Authority to enforce these federal laws is generally delegated to individual states which codify federal requirements into state law, as well as any other measures deemed necessary by the state to protect the public welfare. The most important federal statute to consider when evaluating requirements for air pollutant sources is the Clean Air Act (CAA). One objective of the CAA is to ensure continued attainment and maintenance of air quality at levels prescribed by the National Ambient Air Quality Standards (NAAQS). The NAAQS have been adopted for six criteria air pollutants: sulfur dioxide, nitrogen dioxide, carbon monoxide, particulate matter less than 10 microns, ozone, and lead. Each area of the country is rated with respect to the relationship between measured ambient air pollutant concentrations and the NAAQS for that pollutant. Areas with concentrations less than the NAAQS are said to be in attainment, while areas with concentrations greater than the NAAQS are said to be in nonattainment with the NAAQS. Areas for which there is insufficient information as to whether or not the NAAQS is being achieved are designated unclassifiable, although these areas are generally presumed to have acceptable air quality. The OCP is located in Bradley County which is designated as attainment or unclassifiable/attainment for all criteria pollutants except for lead (Section 7.1.2). The county currently does not have a lead designation.

The CAA stipulates requirements in several program areas relevant to the NDP, including provisions for nonattainment, air toxics, performance standards, and permits.

9.1.1 Nonattainment

The CAA mandates the attainment of the NAAQS. To achieve attainment of the NAAQS the Tennessee Department of Environment and Conservation (TDEC), Division of Air Pollution Control, controls air emissions through the issuance of operating permits. The permits contain operating conditions which limit the emissions of the NAAQS criteria pollutants. Numerous facilities at OCP are regulated by these construction permits. These facilities include but are not limited to the following: Reductone Ventilation/Evacuation System (Permit No. 032923P), Steam Boilers (Permit No. 032922F), and Mercury Processing (Permit No. 037675P).

9.1.2 Air Toxics

A number of air pollutants are regulated as toxic pollutants under the CAA. If a modification to a source results in an increase in emissions equivalent or greater than four tpy of a listed toxic pollutant reduction measures equivalent to the Maximum Achievable Control Technology (MACT) are required. The NDP at the OCP will not release or increase the emissions of any listed air toxic therefore the OCP will not be subject to any new air toxic control requirements.

9.1.3 Performance Standards

New Source Performance Standards (NSPS) exists for many industrial process categories; however, there are no NSPS directly applicable to the NDP.

9.1.4 Permitting

The NDP at OCP will be constructed in an area designated unclassifiable/attainment for criteria pollutants (Section 7.1.2). Existing air quality is therefore presumed to be acceptable. The most important permitting requirement to consider for areas with acceptable air quality are regulations for Prevention of Significant Deterioration (PSD). PSD applies to new major sources or major modifications at existing major sources. PSD may apply to the proposed project if the NDP increases annual potential emissions by the following amounts (reported in tons):

carbon monoxide	100
nitrogen oxides	40
sulfur dioxide	40
PM ₁₀	15
ozone	40 of hydrocarbons
lead	0.6
asbestos	0.007
beryllium	0.0004
mercury	0.1
vinyl chloride	1
fluorides	3
sulfuric acid mist	7
hydrogen sulfide	10
total reduced sulfur	70

However, the NDP will not trigger PSD. Annual emission increases, if any, will be below the PSD threshold amount for each of the compounds listed above.

A construction permit, forms APC21 and APC22, for the liquid SO₂ plant will be filed prior to the start of construction with the TDEC Division of Air Pollution Control. Within ninety days of plant start up an operating permit must be filed with the Division of Air Pollution Control. Information required by TDEC would include a description of the emission control equipment, and information on the nature and amount of pollutants to be emitted. Title V of the Clean Air

Act will require all emissions from the OCP facility to be quantified with this data submitted to the U.S. EPA.

9.2 Land Use

The following land use issues have been discussed in previous sections of the EIV: floodplains (Section 7.3.1.3), wetlands (7.3.1.4), and historic sites (7.6.1). No further notification or permits regarding these issues will be required.

9.3 Waste Disposal

The federal Resource Conservation and Recovery Act (RCRA) of 1976 establishes a comprehensive cradle-to-grave regulatory system for all solid waste (hazardous and non-hazardous). The regulations are intended to govern the management of solid and hazardous waste and include governing the treatment, storage, and disposal of such waste. For the NDP at OCP wastes generated from the liquid SO₂ plant will include spent zeolite molecular seive material and silica gel from the Air Separation Unit and ash material from the Calabrian liquid SO₂ process (Section 8.3). All wastes will be handled in accordance with applicable state and federal regulations.

9.4 Water Quality

9.4.1 Surface Wastewater Discharge

Under the provisions of the federal Clean Water Act and the Tennessee Water Quality Control Act, the TDEC - Division of Water Pollution Control, administers a program to monitor and treat industrial and municipal discharges to the waters of the United States. The agency, through issuance of permits, specifies the terms and conditions under which the OCP may discharge wastewater. OCP currently operates under Permit No. TN0002461. The demonstration project activities will likely not require modifications to the existing NPDES permit; however, the Division of Water Pollution Control will be notified by letter prior to the operation of the NDP about the minor increases in wastewater discharge (Section 8.4.2).

Federal stormwater regulations adopted in 1990 require that stormwater discharges associated with industrial activities be permitted. Stormwaters at the OCP are already identified in the NPDES permit. New paved areas in the facility will be routed to existing drains, therefore a new permit will not be required. Construction projects disturbing more than five acres of land also require permitting; however, the NDP at the OCP will disturb less than two acres during construction.

9.5 Ecology

Under the Endangered Species Act of 1973, DOE must consult with the U.S. Fish and Wildlife Service (USFWS) to ensure that proposed actions are not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse

modification of the critical habitat of such species. The USFWS has indicated that the proposed project is not likely to impact the federally threatened snail darter (Section 7.4.3).

9.6 Miscellaneous

9.6.1 FAA

The FAA requires submittal of a Notice of Proposed Construction or Alteration for projects where the height exceeds 200 feet. Because the tallest NDP structure will be about 110 feet, no FAA notification would be required.

9.6.2 Health and Safety

SO₂ is listed as an extremely hazardous substance under the Emergency Planning and Community Right-to Know Act (EPCRA), Occupational Safety and Health Regulation (OSHA) 1910.119 - Process Safety Management of Highly Hazardous Chemicals, and the Clean Air Act (CAA), Part 68 - Chemical Accident Prevention Provisions. The threshold planning quantity (TPQ) for SO₂, the amount stored on-site which triggers inventory reporting requirements and adherence to the aforementioned regulations, are as follows: 500 pounds for EPCRA, 1,000 pounds for OSHA 1910.119, and 5,000 pounds for CAA Part 68. The current SO₂ inventory at the OCP is above the TPQ's for the hazardous substance regulations and the OCP is in compliance with all applicable hazardous substance regulations. In general, the current OCP documentation required for compliance of these regulations will be updated and expanded to include the addition of the SO₂ plant (Section 8.6.2).

The Emergency Planning and Community Right-to Know Act of 1986 (EPCRA) established government and industry requirements for emergency planning and community reporting on hazardous chemicals. EPCRA provisions include emergency planning, emergency notification, community right-to-know reporting requirements, and toxic chemical release and emissions inventory reporting requirements. The objective of these reporting requirements is to help the state and local communities become informed of chemical hazards in the overall community as well as at individual industrial sites.

OSHA 1910.119 contains requirements for preventing or minimizing the consequences of catastrophic releases of hazardous chemicals. To accomplish this goal OSHA requires a Process Safety Management plan including the following information: process safety information, process safety analysis, operating and training procedures, pre-startup safety review, and an emergency planning and response plan. This document will be developed for the NDP at the OCP. In addition, other potential workforce health and safety issues of the NDP would also be regulated by OSHA.

Under the Clean Air Act, Part 68 a Risk Management Plan would be required. This plan would contain many of the same elements of the OSHA Process Safety Management Plan.

9.6.3 Historic Preservation

In accordance with the provisions of Section 106 of the National Historic Preservation Act of 1966 (36 CFR 800), federal projects must be reviewed to determine their effect on historic properties. To assess the impacts of the project the DOE contacted the Tennessee Department of Environment and Conservation, Historical Commission, for information on cultural and historical properties in the project area. The Historical Commission has indicated the proposed project would not affect any cultural resource eligible for listing in the National Register of Historic Places (Section 8.6.1).